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THIS VOLUME IS DEDICATED TO

EDUARD MEINE VAN ZINDEREN BAKKER (1907—)

PHIL. NAT.D. (AMSTERDAM)

(*Director of the Institute for Environmental Sciences, University of the Orange Free State, Bloemfontein*)

Professor van Zinderen Bakker emigrated to South Africa in 1947 and became head of the Department of Botany of U.O.F.S. at Bloemfontein from 1963–1972. He initiated palynological studies in Africa and has become an authority on the history of the vegetation and climate of Africa during the Quaternary. Besides this he has achieved international recognition for his long term intensive biological research programme on the sub-Antarctic islands Marion and Prince Edward. He also organised extensive limnological research.

Prof. Bakker still serves as chairman and member on four international research bodies in connection with Antarctic and palynological research. He is member of the editorial board of two international scientific journals. Among some of his rewards are the Senior Captain Scott Medal, the Gold Medal of the S.A. Antarctic Association, the Gold Medal of the S.A. Association of Botanists. He is a Fellow of the Royal Society of S.A., Officer in the Order of Orange Nassau and was Honorary Consul of the Netherlands (1953–1973).

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NOTES ON THE DISTRIBUTION AND COMPARATIVE LEAF MORPHOLOGY OF THE ACAULESCENT SPECIES OF *STRELITZIA* AIT.

H. A. van de Venter, J. G. C. Small and P. J. Robbertse*
(*Department of Botany, University of Port Elizabeth*)

Abstract

Plants of *S. reginae* encountered in the wild represent a wide variety of leaf shapes and sizes. The junceous form of *Strelitzia* cannot be regarded as part of this variation as it is a distinct morphological entity found in extensive stands in the Uitenhage and Port Elizabeth areas. Seedlings of these two growth forms, which were raised in a growth cabinet, show morphological and ontogenetic differences right from the early growth stages. It is therefore proposed that *S. juncea* be regarded as a seperate species.

A population containing a variety of leaf forms intermediate between *S. reginae* and *S. juncea* was encountered near Patensie. The possibility that these plants are *S. reginae*×*S. juncea* hybrids needs to be investigated.

Although odd clones approximating the description of *S. parvifolia* do exist in the wild, the data presented in this paper suggest that this growth form does not merit specific rank.

Uittreksel

AANTEKENINGE OOR DIE VERSPREIDING EN VERGELYKENDE BLAARMORFOLOGIE VAN DIE ONGESTINGELDE SPESIES VAN *STRELITZIA* AIT.

Plante van *S. reginae* wat in die veld aangetref word, verteenwoordig 'n groot verskeidenheid van blaargroottes en -vorms. Die biesieagtige groeivorm van *Strelitzia* kan nie as deel van hierdie variasie beskou word nie aangesien dit 'n eiesoortige morfologiese entiteit is wat in uitgebreide stande in die Uitenhage en Port Elizabeth omgewings voorkom. Saailinge van hierdie twee groeivorms, wat in 'n groeikabinet gekweek is, het vanaf die vroegste groeistadia verskil ten opsigte van hul morfologie en ontogenetiese ontwikkeling. Dit word dus voorgestel dat *S. Juncea* as 'n afsonderlike spesie beskou word.

'n Bevolking wat naby Patensie aangetref is, bevat 'n verskeidenheid van blaarvorms intermediêr tussen die van *S. reginae* en *S. juncea*. Die moontlikheid dat hierdie plante *S. reginae*×*S. juncea* basters is, regverdig verdere navorsing.

Alhoewel enkele klone wat aan die beskrywing van *S. parvifolia* voldoen, wel in die veld aangetref word, dui die gegewens wat in hierdie artikel aangebied word, daarop dat hierdie groeivorm nie as 'n afsonderlike spesie erken behoort te word nie.

Introduction

Two acaulescent species of *Strelitzia* are described in *Flora Capensis* (Wright, 1913) namely, *Strelitzia reginae* Ait. and *S. parvifolia* Ait.

Strelitzia reginae is described as having leaf blades approximately 45 cm (1,5 ft) long and 10 cm (4 in) wide with the margins undulate, especially in the lower part. Five varieties are differentiated on the basis of characteristics such as lamina shape and size and petiole length. Four of these varieties are known from cultivated specimens only.

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Strelitzia parvifolia is distinguished from *S. reginae* on the basis of lamina size. The leaf blade of this species is reported to be approximately 23 cm (9 in) long and 7,5 cm (3 in) wide. The lamina has a flat margin. Only one variety (var. *juncea* Ker-Gawler) is listed and is described as a form which has either a very small leaf blade, or none at all.

Moore and Hyypio (1970) expressed the opinion that only one acaulescent species should be recognised, namely *S. reginae*. They suggest that as there are no discernible characters of the flower to separate *S. parvifolia* from *S. reginae*, and as this form probably represents no more than an anomalous clone of *S. reginae*, *S. parvifolia* does not merit specific rank.

Moore and Hyypio (1970) mention that the variant with no leaf blade was described independently in 1821 as *S. juncea* Link and *S. parvifolia* var. *juncea* Ker-Gawler, both from plants in cultivation. As distinctions from *S. reginae* other than in the lack of leaf blade are not apparent, and as its distribution in South Africa is not well documented, Moore and Hyypio decided to reduce *S. juncea* to *S. reginae* where, if desired, it could be designated as a cultivar—cv. 'Juncea'.

Dr. R. A. Dyer of the Botanical Research Institute in Pretoria (personal communication) felt that this treatment was too drastic. In a publication on the vegetative multiplication of the acaulescent species of *Strelitzia*, Dyer (1972) recognizes two species, namely *S. reginae* Ait. and *S. juncea* Link.

In view of these conflicting opinions a study of the distribution and leaf morphology of *S. reginae* and its allies was undertaken.

MATERIALS AND METHODS

Various field trips were undertaken to examine *Strelitzia* species growing in the wild. Using data obtained in this way, as well as data made available by various herbaria, a distribution map of the acaulescent species was compiled. The opportunity was also used to plot the distribution of the caulescent species.

To permit morphological comparisons on a rational basis, measurement of various parameters (see Table 1) were taken on plants growing at three localities. The following growth forms were compared in this way:

(a) Plants growing in Pluto's Vale, 4 km from Ecca Pass (approximately 26 km from Grahamstown). Although a fair amount of variation in lamina shape and size was encountered in this population, the plants were all regarded as specimens of *S. reginae* because of the presence of a prominent leaf blade. None of the plants resembled the junceous form encountered in the Uitenhage area.

(b) Plants growing on the farm Brackhill, 26 km from Uitenhage on the national road to Graaff-Reinet. These plants were very typical of the various uniform *Strelitzia* populations to be found in this area. The leaves on all the plants either have extremely reduced laminae, or none at all. These plants are referred to as *S. juncea* in this text. None of the plants in this area were morphologically identical to any of the plants found at Pluto's Vale.

(c) Plants growing in the Vensterhoek area about 16 km from Patensie. A variety of growth forms was encountered in this population. Some of the plants resembled the *S. reginae* specimens at Pluto's Vale, others were similar to the junceous form found in the Uitenhage area, while a host of other plants was found with laminae of intermediate shapes and sizes.

The acaulescent species of *Strelitzia* occur in the wild as isolated "clumps" (see Fig. 3). These specimens are not individual plants, as they superficially appear to be, but are a group of plants which have resulted from the vegetative multiplication of the original parent plant as described by Dyer (1972). The individual clumps encountered in the field will subsequently be referred to as clones.

Measurements were taken on ten randomly selected leaves and inflorescences in each clone. At Pluto's Vale and Brackhill the survey was conducted on twenty randomly selected clones and mean values computed. Due to the striking variations in leaf morphology of plants growing at Venterhoek, the values recorded at this locality represent means from individual clones.

As environmental differences may result in morphological differences, a comparison of plants of *S. juncea* and *S. reginae* grown under identical conditions in a growth cabinet was also made. For this purpose seeds of *S. reginae* were collected from plants growing in the veld near East London while those of *S. juncea* were collected in the Uitenhage area. In both cases the plants were not growing near any differing growth forms so that the possibility that cross-pollination with such forms could have taken place was negligable.

The seeds were germinated aseptically in petri dishes and the seedlings transferred to a vermiculite substrate in plastic containers of one litre capacity. As growth proceded the plants were transplanted to larger pots. Nutrients were supplied by means of biweekly applications of a complete nutrient solution. The relative proportions of the different macro-elements in the solution were based on the formulation used by Murray (1959) for *Musa* species.

The plants were grown in a Percival model PGW-132 growth cabinet at day/night temperatures of 26/18 °C. A photoperiod of 14 hours with a light intensity of approximately 20 000 lux was maintained.

Leaf measurement of the plants were taken from time to time.

RESULTS

The distribution of *Strelitzia* species in South Africa is depicted in Fig. 1.

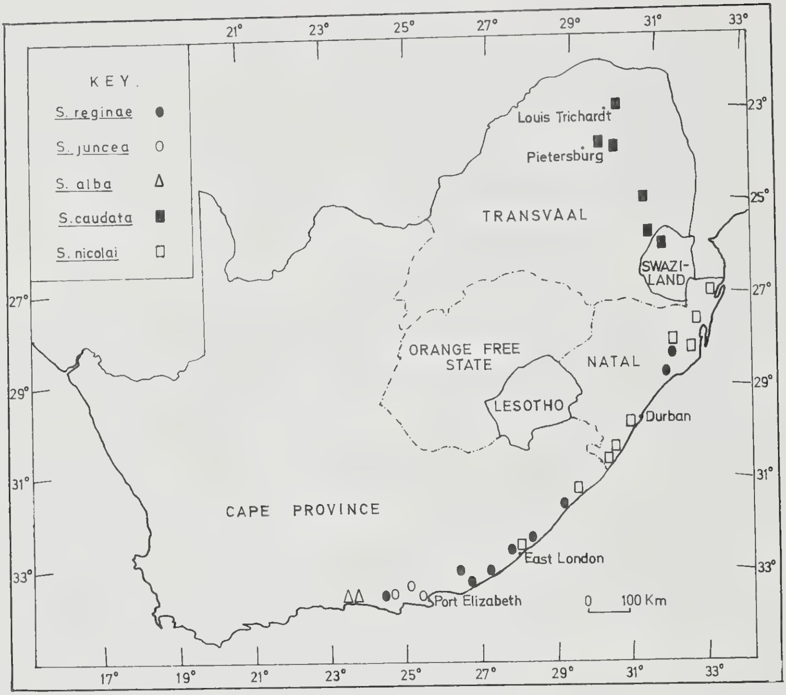


Fig. 1.
Distribution of *Strelitzia* species in South Africa.

The herbarium specimens used in the compilation of this map are listed in the appendix.

S. reginae

This species is distributed along the east coast of South Africa from Patensie to Zululand. It could not be ascertained whether the plant has ever been found in the wild on the south coast of Natal.

The largest populations of this species were found at Ecca Pass and Pluto's Vale, near Grahamstown. The average size of laminae in the Pluto's Vale population was found to be smaller than the size recorded in *Flora Capensis* for the species. In Table 1 it can be seen that the mean lamina length was 33 cm and mean lamina width 10 cm. However, a large amount of variation in leaf size was found. A clone with laminae on the average 41 cm long and 5 cm wide was encountered as well as one with laminae 29 cm long and 8,5 cm wide.

In Fig. 2 an extreme example is pictured—leaf blades 30 cm long and 3 cm wide.

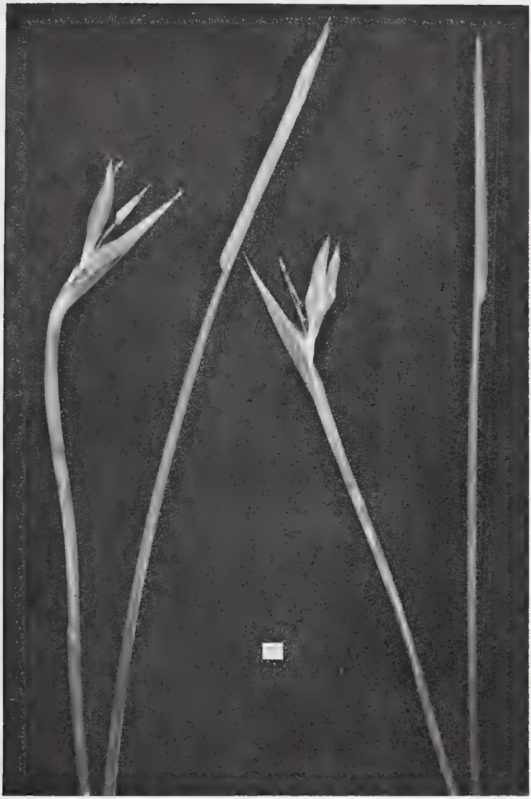


FIG. 2.
Leaves and flowers of a *S. reginae* clone found at Pluto's Vale.

Considerable variation in lamina size, as well as lamina shape, was also encountered among *S. reginae* plants growing elsewhere. It would seem that leaf size is influenced to a large degree by environmental conditions. Plants in the wild growing in dense bush or a clump of trees invariably have abnormally long petioles—and yet this is a criterion which is used to differentiate between varieties in *Flora Capensis*. Plants in cultivation often grow to a greater height than those found in the wild.

TABLE 1—Some dimensions (in cm) of three populations* of acaulescent growth forms of *Strelitzia*

Locality	Pluto's Vale	Brackhill	Vensterhoek							
Species	*S. reginae*	*S. juncea*	*S. reginae*	*S. juncea*	Intermediate forms					
Clone height (length of longest leaf)	142	195	140	160	170	200	160	170	170	190
Clone diameter (ground level)	153	90	150	50	400	140	75	120	200	130
Total length of leaf	108	165	127	135	137	146	134	136	148	169
Petiole length	75	165	98	130	124	124	114	125	140	153
Lamina length	33	**	29	5**	13	22	20***	11**	8**	16**
Lamina width	10		11	0,5	4,5	3	2	1,5	1	0,5
Scape length	88	104	107	97	—	94	110	108	83	96
Spathe length	20	20	24	21	—	19	20	18	18	20
Number of inflorescences per clone	12	13	6	7	0	8	3	2	7	12

* Values for Pluto's Vale and Brackhill represent averages from 20 clones.
Values for Vensterhoek represent measurements of individual clones.
** Leaf apices normally sclerotic.
*** Leaf apices slightly sclerotic.

In the light of the extensive variation in leaf shape and size of plants of *S. reginae*, two points may be emphasized:

(a) It is meaningless to delineate the species in terms of leaf shape and size unless very wide limits are set.

(b) The indescriminate recognition of varieties on the basis of criteria such as these, especially from plants in cultivation, can serve no useful purpose and only lead to confusion.

S. juncea

An acaulescent form of *Strelitzia* which is quite distinct from *S. reginae* as far as appearance is concerned, occurs in relatively extensive stands at different localities north west of Uitenhage. Two populations are also located in the Port Elizabeth area; one at Coega Kop and the other in Gelanse Kloof. Junceous forms are also found at Vensterhoek.

Plants of this species have a bizarre appearance (see Fig. 3). The foliage consists of long, erect petioles which, as a rule, have sclerotic apices (d in Fig. 4). In some cases the petiole tip dies back for a considerable distance (e in Fig. 4).

When viewed from a distance, all the leaves of this growth form seem to be devoid of laminae. On closer examination, however, it can be seen that the

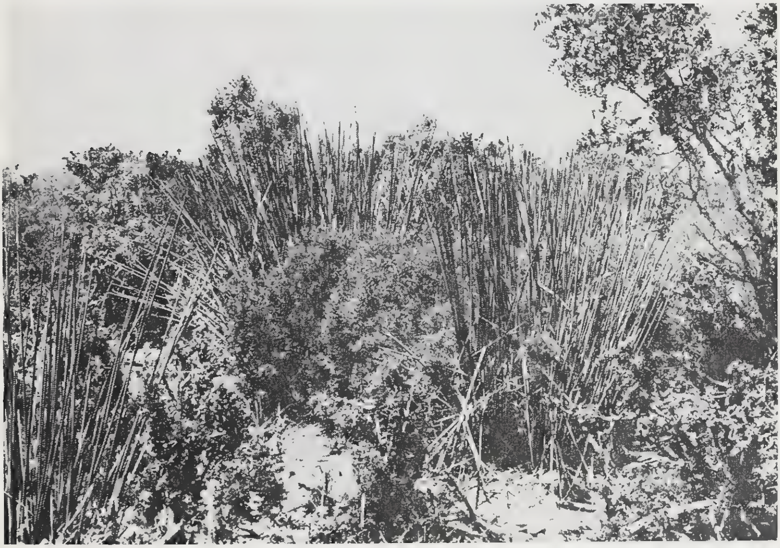


FIG. 3.
Clones of *S. juncea* in the veld near Uitenhage.

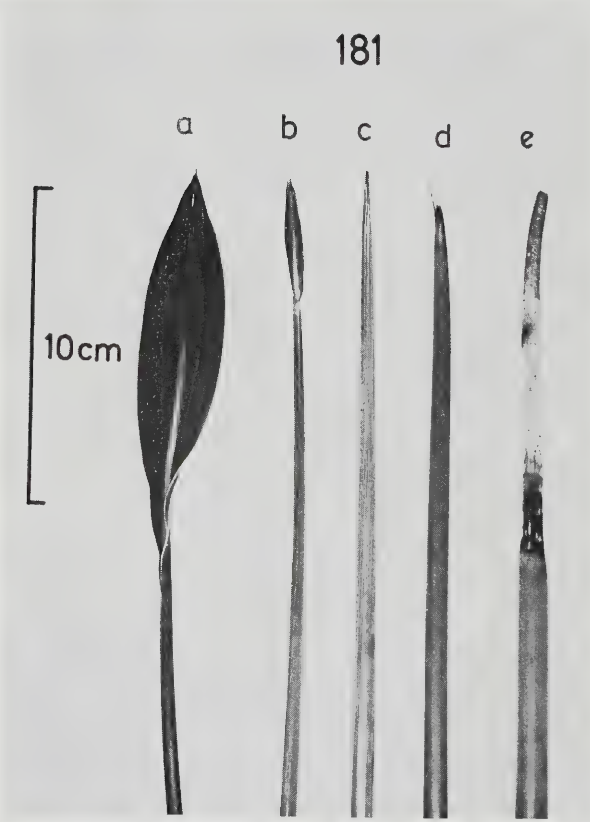


Fig. 4.
Leaf-forms encountered on *S. juncea* plants.

petioles of some of the plants support a very small lamina which is approximately 4 cm long and 0,5 cm wide (b in Fig. 4). Some leaves do not have small laminae or sclerotic tips, but only a small groove in the petiole apex (c in Fig. 4).

Leaves with laminae measuring approximately 10 cm by 2–4 cm are also encountered on *S. juncea* plants (a in Fig. 4). Such laminae are occasionally found on mature plants and are carried on very short petioles. They are commonly seen, however, as regrowth after the foliage of mature plants has been cut down to almost ground level. As seedlings of *S. juncea* produce leaves which are distinctly laminate (see Fig. 5), the large lamina probably represents a juvenile leaf form.

The data in Table 1 show that the *S. juncea* plants examined were taller than the plants of *S. reginae*. Although these figures were obtained from plants growing at different localities and are, therefore, not strictly comparable, they probably do reflect genetic differences. Where the two species are cultivated in close proximity, such as at Kirstenbosch and in various parks in Port Elizabeth, it can be seen that the plants of *S. juncea* are invariably taller than those of *S. reginae*.

The leaves of plants of *S. juncea* at Brackhill were almost 60 cm longer than leaves of *S. reginae* plants in Pluto's Vale (see Table 1). It is also important to note that the average leaf length of 165 cm in the case of *S. juncea* actually represents the length of the petiole only. In the case of *S. reginae*, the average leaf length of 108 cm includes 75 cm of lamina. The petioles of these plants are therefore less than half as long as the petioles of *S. juncea*.

Although measurements were not taken of any of the plants growing in the Port Elizabeth area, these plants seem to resemble those growing near Uitenhage in all respects.

Growth forms at Vensterhoek

A very interesting population of acaulescent *Strelitzia* plants was encountered at Vensterhoek near Patensie. In this rather scattered population are plants which resemble *S. reginae* as well as plants which resemble *S. juncea*. The reduced laminae of the junceous plants are, however, slightly longer than is the case for plants of this form in the Uitenhage area. The junceous forms at Vensterhoek frequently have leaves which have died back from the tip so that only the sclerotic remains of these laminae are seen.

Also to be found in this population are plants representing a large variety of lamina shapes and sizes. Some of these plants are described by the data in Table 1 and it can be seen that some clones have laminae of unusual proportions in comparison with laminae of "typical" *S. reginae* and *S. juncea* plants.

The variation found at Vensterhoek is reminiscent of the so-called "hybrid scatter" which occurs after cross-pollination between species. It is possible that these intermediate forms are *S. reginae* × *S. juncea* hybrids. This possibility will be investigated in the near future.

S. parvifolia

As far as could be ascertained, there are no herbarium specimens of this species in South Africa. The only record of the species which could be traced is a photograph of a specimen in the herbarium of the Royal Botanic Gardens at Kew. The lamina of this specimen is approximately 22 cm long and 4 cm wide. The only clue as to locality is the annotation "Cape". It is interesting that *Flora Capensis* does not mention any specific locality for this species either.

No uniform stand of plants conforming to the description of *S. parvifolia* or resembling the specimen at Kew were encountered anywhere in the veld. There are, no doubt, clones at Pluto's Vale and Vensterhoek which would fit the description of *S. parvifolia*. However, in the light of the variation between the different clones it would be ridiculous to accept any such variant as a separate species.

No other conclusion can be drawn but that *S. parvifolia* does not merit specific rank. This is in agreement with the opinion of Moore and Hyypio (1970).

Comparative morphology of seedlings in a controlled environment

No differences in external morphology are evident as far as germinating seeds of *S. reginae* and *S. juncea* are concerned. Differences are, however, apparent in the seedlings which develop from these seeds.

The laminae of *S. reginae* seedlings are larger than those of *S. juncea*, a difference which can be seen even after the lamina of the first laminate leaf has extended (see Fig. 5a).

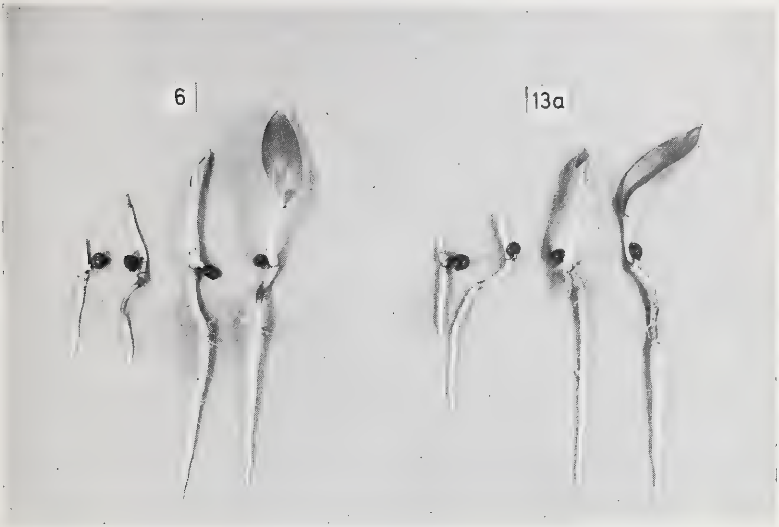
As successive leaves of *S. reginae* seedlings appear, a progressive increase in lamina size is found. A different pattern of development is encountered in seedlings of *S. juncea*. (See Figs. 5 and 6).

Laminae of *S. juncea* seedlings show an increase in size only up to about the eighth leaf, depending on the individual seedling. Hereafter successive leaves show a progressive decline in lamina size. The lamina of the twelfth leaf of the *S. juncea* specimen shown in Fig. 5c (that is, the longest leaf shown in the figure) is barely visible and is typical of laminae found on mature plants of *S. juncea*. This lamina was found to be 4,0 cm long and 0,7 cm wide.

The first few leaves of *S. reginae* have longer petioles than the corresponding leaves on *S. juncea* seedlings. From the eighth leaf onwards, however, *S. juncea* produces longer petioles than *S. reginae*.

All the leaves of *S. juncea* have a higher ratio of petiole length to lamina length in comparison with leaves of *S. reginae*. The tenth leaf of *S. juncea* plants, for instance, has a petiole which is, on the average 4,89 times longer than the lamina. The petiole of the tenth leaf of *S. reginae* plants is only 1,38 times longer than the lamina. The twelfth leaf of the *S. juncea* specimen pictured in Fig. 5 has a petiole length: lamina length ratio of 20.

Differences in lamina shape between the two species were also recorded. The laminae of *S. juncea* are generally elliptic. The first few leaves of *S. reginae* also have an elliptic form while those appearing later are decidedly lanceolate.



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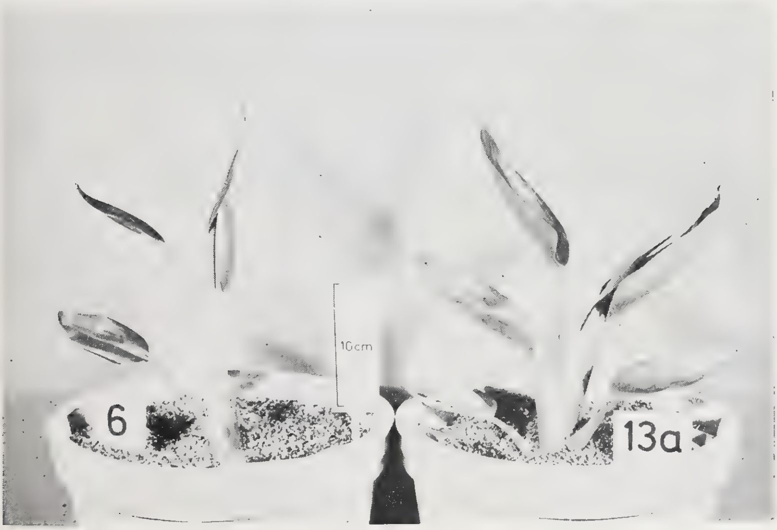

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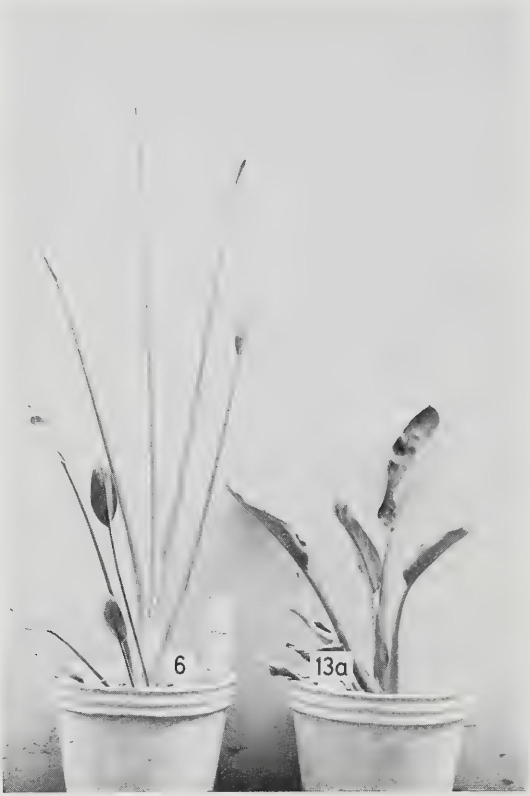

c

FIG. 5.

Comparison of growth of seedlings of *S. juncea* (no. 6) and *S. reginae* (no. 13a) in a controlled environment a. Germinating seeds; b. Plants after eight months of growth; c. Plants after 15,5 months of growth.

DISCUSSION

The data presented in this paper confirm the view of Moore and Hyypio (1970) that *S. parvifolia* does not merit recognition at specific level. Plants of *S. reginae* encountered in the wild exhibit a wide range of leaf shapes and sizes and some of these clones probably approximate the description of *S. parvifolia* as recorded in *Flora Capensis*.

The junceous form cannot be regarded as part of the variation within *S. reginae*. It is a distinct morphological entity and can be distinguished from

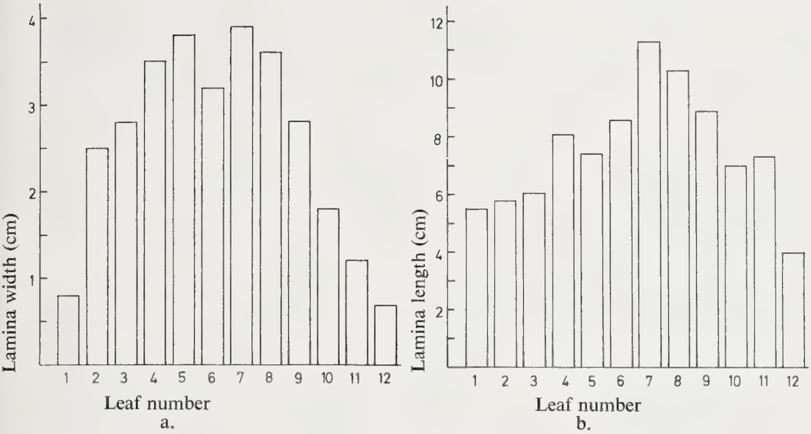

FIG. 6.
Lamina measurements of a young *S. juncea* plant a. Lamina width b. Lamina length.

S. reginae under a wide range of environmental conditions. The ontogenetic development of the plants also differs from the early growth stages of the seedlings.

The distribution of *S. juncea* is also distinct from that of *S. reginae*. Apart from plants in cultivation, a mixed stand of the two species was only found at one locality, namely Vensterhoek. Admittedly the various growth forms found at this locality do present a classification problem and further research is required on this population. The possibility that these intermediate growth forms could be *S. reginae* × *S. juncea* hybrids needs to be investigated. Apart from cross-pollination studies, the approach of Fröst and Bose (1966) and Fröst and Ising (1968) using chemical systematic methods might prove valuable in this respect.

Attempts at a cytological comparison of *S. reginae* and *S. juncea* have been made but the mitotic figures obtained so far have not been sufficiently clear to justify a definite conclusion.

In the light of the data presented in this paper it is suggested that the junceous form maintains the name *S. juncea* Link. Furthermore, it is proposed that the key presented by Moore and Hyypio (1970) be modified with respect to the acaulescent species of *Strelitzia*. The following is proposed:

Flowers with orange to yellow sepals and deep blue-violet petals; pendunclesof inflorescences elongate, erect from the leaf axils; erect stems not developed.

Leaf blades prominent, at least 3 cm wide and 30 cm long, usually wider and longer (1) *S. reginae*

Leaf blades absent, or very reduced. Petioles usually terminate in dead apex. (2) *S. juncea*

In the case of *S. reginae* such a diversity of lamina shapes and sizes is encountered that it would hardly be rewarding to attempt a classification at the intraspecific level.

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APPENDIX

The following herbarium specimens were used for the compilation of the distribution map of *Strelitzia* (Fig. 1):

S. alba

CAPE PROVINCE—3323 (Willowmore): Groot Rivier Pass (-CD), abundant on steep slopes and occasional in forest near streams, *Dyer 5329* (PRE); on eastern slopes, *Small and Robbertse 3* (PEU); in forest and on ledges of cliffs, *Keet s.n.* (GRA); Blauwkrantz (-DC), Groot Kloof, *Schmidt s.n.* (GRA); Storms River (-DD), on steep slopes of thickly wooded kloof, *Fourcade s.n.* (GRA).

S. caudata

TRANSVAAL—2329 (Pietersburg): Pietersburg (-DD), Woodbush Forest Station, *Grewcock s.n.* (PRE). Type: 2330 (Tzaneen): Zoutpansberg (-AA), from farm "Geluk", 23 km East of Louis Trichardt, *Veschuur s.n.* (PRE); Piesanghoek (-AA), amongst rocks in dense bush on summit and on rocks on bush-covered krans on mountainside, *Galpin s.n.* (PRE); Louis Trichardt (-AA), in Widdringtonia bush of Piesanghoek, *Gerstner 5784* (PRE); Westphalia (-CC), Pietersburg district, *Burtt-Davy s.n.* (PRE); Letaba (-CD), *Scheepers 428* (PRE). 2430 (Pilgrim's Rest): Pilgrim's Rest (-DD), *v.d. Schijff 6462* (PRE). 2531 (Komatipoort): Barberton (-CC), *Dyer 4802* (PRE).

SWAZILAND—2531 (Komatipoort): Pigg's Peak (-CD), *Heenan s.n.* (PRE).

S. juncea

CAPE PROVINCE—3324 (Steytlerville): Vensterhoek (-DD), on farm Vensterhoek, *Small and Robbertse 28* (PEU); *van de Venter 147* (PEU). 3325 (Port Elizabeth): Brackhill (-CB), on northern slope, *Small and Robbertse 6; 55* (PEU); Prentice Kraal (-CB), on northern slopes on side of Uitenhage—Jansenville road, *van de Venter 181* (PEU); Uitenhage (-CB), scrubveld 5 km from Uitenhage on Steytlerville road, *Admiraal 468* (PRE); 16 km from Uitenhage on Steytlerville road in Karroid scrub, *Dyer 4832* (PRE); *Dyer and Wells 5820* (PRE); on mountains, *Patterson 665* (GRA); Uitenhage, *Thode A 2752* (PRE); Port Elizabeth (-DA), on northern slopes in Gelanse Kloof, above Salsoniville, *van de Venter 213* (PEU); Bethelsdorp, *Patterson 665* (GRA).

S. nicolai

NATAL—2632 (Bela Vista): Zululand (-DD), Kosi Bay, *Rodni 4610* (PRE). 2732 (Ubombo): Ubombo (-CA), 12 km S.W. of Manzengwenya on road to Mbazwana, *de Winter and Vahrmeijer 8589* (PRE). 2831 (Nkandla): Hlabisa (-BB), *Ward 4417* (PRE). 2832 (Mtubatuba): Mtubatuba (-AC), coastal sandflats, scrub with scattered trees, Palm Ridge farm, *Harrison 414* (PRE). 2930 (Pietermaritzburg): Isipingobeach (-DD), *Ward 854* (PRE). 3030 (Port Shepstone): Margate (-CD), *Prosser s.n.* (PRE); Southport (-DA), *Bruce 437* (PRE).

CAPE PROVINCE—3228 (Butterworth): (-CC), on bank of lagoon, *van de Venter 60* (PEU).

S. reginae

NATAL—2831 (Nkandla): Nxeba Ridge (-BD), hill near junction of Black and White Umfolozi Rivers, *Barret s.n.* (PRE); Mpila Hill, Umfolozi Game Reserve (-BD), on steep slope amongst rocks, *Borquin 533* (PRE); Heatonville (-DB), on banks of spruit, *Houting s.n.* (PRE); Empangeni (-DD), in bush on banks of stream, *Houting s.n.* (GRA).

CAPE PROVINCE—3129 (Port St. Johns): Mtata River (-CC), short distance north of Coffee Bay on coast, *Vogts s.n.* (PRE). 3227 (Stutterheim): near East London—Nahoon road (-DD), *van de Venter 169* (PEU); Arnoldton (-DD) on farm "Fairview", *van de Venter 176* (PEU). 3228 (Butterworth): Kei Mouth (-CB), *Flanagan 1706* (PRE); 6 km from river mouth, *Small and Robbertse 21* (PEU); Cintsa (-CC), 5 km from coast on banks of stream, *Small and Robbertse 16* (PEU); Kwelera (-CC), on stream bank in shade of gully bush, 75 km from Kwelera on road to East London, *Comins s.n.* (GRA). 3324 (Steytlerville): Vensterhoek (-DD), on farm Vensterhoek, *Small and Robbertse 32;*

33; 150 (PEU); *van de Venter 149* (PEU). 3326 (Grahamstown): Ecca Pass (-BA), eastern slopes, *Small and Robbertse 8; 34* (PEU); Pluto's Vale (-BA), *Small and Robbertse 56; 57; 58; 170–174* (PEU); Kariege Rivier (-DA), im walde *Zeyher 3953* (GRA); Port Alfred (-DB), on banks of stream under dense bush, *Small and Robbertse 10* (PEU). 3327 (Peddie): Keiskamma River (-AB), 16 km from mouth in dense bush, *Small and Robbertse 11* (PEU); East London (-BB), hillsides along Buffalo River, *Galpin s.n.* (PRE); Keiskamma (-BC), *Sim 19927* (PRE).

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AN AUTORADIOGRAPHIC STUDY OF THE TRANSLOCATION OF ^{14}C-LABELLED ASSIMILATES IN *ERAGROSTIS CURVULA* (SCHRAD.) NEES AT DIFFERENT STAGES OF VEGETATIVE GROWTH

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Abstract

Autoradiography was used to study the movement of ^{14}C-labelled assimilates in *Eragrostis curvula* at several stages of vegetative growth. The assimilates were labelled by allowing single leaves of plants to photosynthesize in an atmosphere containing radioactive carbon-dioxide ($^{14}CO_2$). Leaves of different ages, located on different tillers, were treated.

Assimilates were exported mainly to growing regions, such as young developing leaves, and to the roots. The pattern of distribution of assimilates changed during the growth of the plant. During the early stages of development (seedling to four-tiller stage) there was extensive intertiller translocation between the main and daughter tillers and vice versa. During the later stages of growth (six-tiller to mature vegetative stage) intertiller translocation decreased considerably and tillers became more independent.

Uittreksel

'N OUTORADIOGRAFIESE STUDIE VAN DIE TRANSLOKASIE VAN ^{14}C-GEMERKTE ASSIMILATE IN *ERAGROSTIS CURVULA* (SCHRAD.) NEES BY VERSKILLENDE VEGETATIEWE GROEISTADIA.

Outoradiografie is gebruik om die beweging van ^{14}C-gemerkte assimilate in *Eragrostis curvula* by verskillende vegetatiewe groeistadia te bepaal. Assimilate is gemerk deur enkele blare van plante te laat fotositetiseer in 'n atmosfeer wat radio-aktiewe koolstofdioksied ($^{14}CO_2$) bevat. Blare van verskillende ouderdomme, en op verskillende lote is so behandel.

Assimilate is hoofsaaklik vervoer na groeiende dele soos jong, ontwikkelende blare, en na die wortels. Die distribusiepatroon van assimilate het verander terwyl die plant gegroei het. Gedurende die vroeë groeistadia (kiemplant tot 4-loot stadium) was daar uitgebreide interloot-translokasie tussen die hoof- en dogter-lote en omgekeerd. Gedurende latere groeistadia (6-loot tot volwasse vegetatiewe stadium) het interloot-translokasie aansienlik afgeneem, en het lote meer onafhanklik geword.

Introduction

The translocation of ^{14}C-labelled assimilates in members of the Gramineae has been the subject of several investigations. Well-defined distribution patterns of assimilates have been found in cereals, such as wheat (Quinlan and Sagar, 1962; Lupton, 1966) and in grasses such as *Phleum pratense* L (Williams, 1964) and *Lolium multiflorum* Lam. (Sagar and Marshall, 1966; Marshall, 1967). These studies have shown how the various parts of a graminaceous plant are interrelated in terms of assimilate movement. The object of the present study was to contribute to work done in this direction since little is known about the distribution patterns of photosynthetic assimilates in grasses indigenous to

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South Africa. *Eragrostis curvula* was chosen because it is not only a common veld grass but is also important agronomically.

MATERIAL AND METHODS

Cultural conditions:

Seeds of *Eragrostis curvula* (Ermelo cultivar) were sown in 15 cm clay pots containing a 1:1 mixture of sand and soil. The sand and soil were autoclaved at a pressure of 1 bar for 15 min prior to filling the pots. The plants were grown in a temperature-controlled glasshouse which was provided with two air-conditioning units. This ensured that the plants were not exposed to very high or low temperatures. Natural daylight was extended by six 200 watt mercury-tungsten lamps to give a 16h photoperiod. Watering was carried out as frequently as necessary to prevent any moisture shortage. Small applications of a commercial fertilizer were made uniformly to each pot.

Under these conditions plants were healthy and grew vigorously. Seedlings were selected for uniformity and thinned to four per pot. When most plants had two tillers, selection for uniform development was again carried out, and the plants were thinned to one per pot.

Assimilation of $^{14}CO_2$

The method used to introduce labelled carbon into plants was based on a technique similar to that of Quinlan and Sagar (1962). Single leaves of plants were allowed to photosynthesize in an atmosphere containing $^{14}CO_2$. Radioactive carbon-dioxide was produced by the addition of excess 50 per cent lactic acid to an aqueous solution of ^{14}C-labelled sodium carbonate ($Na_2{}^{14}CO_3$). The specific activity of the sodium carbonate was 10 mc/mM.

In preliminary experiments it was found that a good autoradiographic image could be produced if small plants (seedling to six-tiller stage) received a dose of 0,5 μc of radioactivity and bigger plants (eight-tiller to mature vegetative stage) 1 μc. A larger dose was required for larger plants because of dilution of the tracer within the plant.

The administration of $^{14}CO_2$ was performed in the glasshouse in bright sunlight on a clear day. The assimilation period lasted for 6h, from 0930 to 1530h. The plants were left in the glasshouse and harvested 18h later.

Autoradiography:

Soil was carefully washed free from the roots and the plants were freeze-dried and autoradiographed following a technique modified from Yamaguchi and Crafts (1958), Little (1962) and Crafts and Yamaguchi (1964).

Mounted plants were exposed to Kodak Blue Brand X-ray film for two weeks if the radioactive dose was 0,5 μc or for 1 week if 1 μc of radio-activity was given. The manufacturer's instructions for processing X-ray films were followed.

Treatments:

Treatments were carried out at seven different stages spanning the development of the plant. These stages together with the leaves which were treated are shown in Table 1.

TABLE 1.

Leaves which assimilated $^{14}Co_2$ in plants at different stages of development.

STAGE OF DEVELOPMENT	TREATMENT LEAVES			
(i) Seedling	Youngest fully expanded leaf on main tiller	Oldest green leaf on main tiller	—	—
(ii) 1-Tiller				
(iii) 2-Tiller			Youngest fully expanded leaf on oldest daughter tiller	Youngest fully expanded leaf on youngest daughter tiller
(iv) 4-Tiller				
(v) 6-Tiller				—
(vi) 8-Tiller				as above
(vii) Mature Vegetative				—

In this investigation, the primary or dominant tiller was referred to as the main tiller and the secondary or subsidiary tillers were called daughter tillers. A diagrammatic representation of a plant at the four-tiller stage is illustrated in Fig. 1. The main tiller (MT) is shown, together with the four daughter tillers (T_1, T_2, T_3, T_4) at different stages of development (T_1, oldest and T_4 youngest). The youngest fully expanded leaf (indicated by numeral I) on the main tiller and on the oldest and youngest daughter tillers, is shown. A fully expanded leaf was recognized by a clearly visible ligule. In addition, the oldest green leaf on the main tiller (II) is shown.

Each plant was treated on a single leaf, different plants being used to determine the patterns of distribution of labelled assimilates from the different leaves. Uniform plants were selected for treatment. Each treatment was replicated twice.

RESULTS

The results are presented as visual assessments of autoradiographs. Photographs of mounted plants and their corresponding autoradiographs are shown. Since there was very close agreement between replicates in the majority of

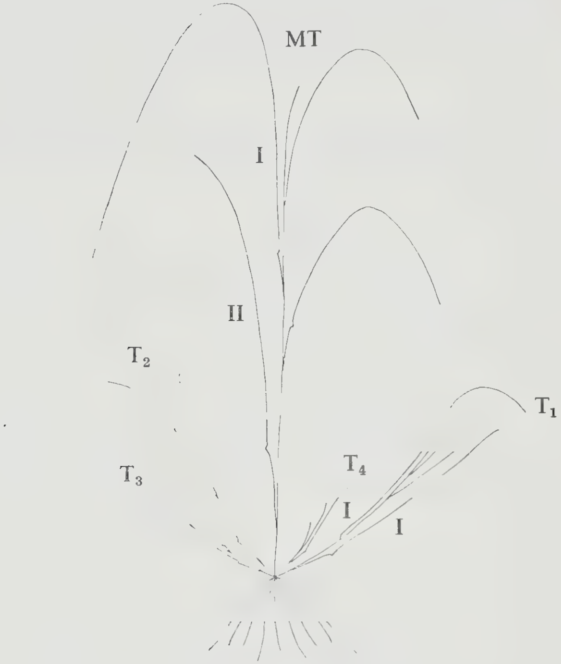


FIG. 1.
Diagrammatic representation of a plant at the four-tiller stage of development.

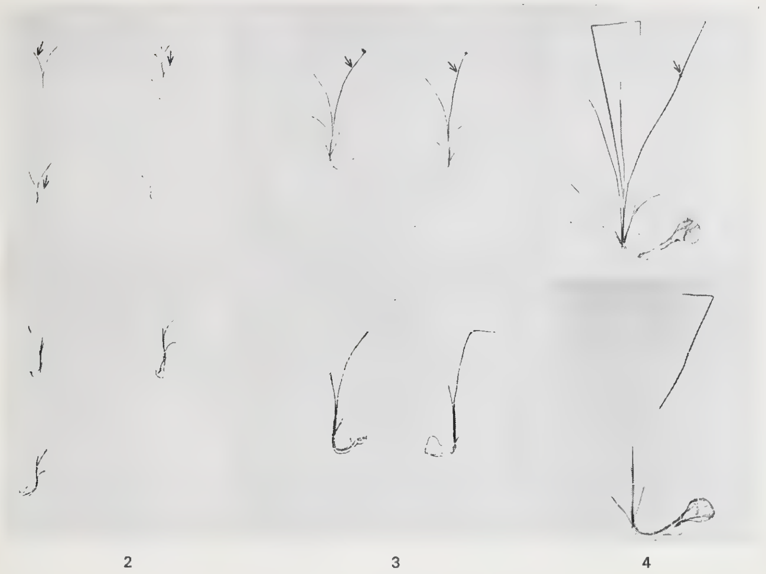
treatments, only one replicate set, unless otherwise stated, is presented. In the photographs of the mounted plants, the treated leaf is indicated by an arrow.

The patterns of distribution of labelled assimilates during the various vegetative stages of growth, following assimilation of $^{14}CO_2$ by single leaves of different ages located on either the main or daughter tillers are shown in Figs. 2–13.

(a) *Treatment of youngest fully expanded leaf on main tiller:*

In the seedling stage (Fig. 2, plant at upper left hand corner), ^{14}C-assimilates from the treated leaf moved mainly to those parts which were actively growing, accumulating in the young developing leaf, in the lower part of the expanding leaf, in the roots and to a lesser extent in the mature leaf.

An unlabelled plant, at the lower right hand corner of Fig. 2, was treated in exactly the same way as the other three labelled plants. As can be seen, it did



FIGS. 2–4

Photographs of mounted plants above, autoradiographs below. Fig. 2. Treatments of plants at the seedling stage: Youngest fully expanded leaf treated (plant at upper left hand corner); oldest green leaf treated (plants at upper right and lower left hand corners); and an untreated plant (lower right hand corner). Fig. 3. Youngest fully expanded leaf on main tiller of a duplicate set of plants at the one-tiller stage treated. Fig. 4. Youngest fully expanded leaf on main tiller of a plant at the two-tiller stage treated.

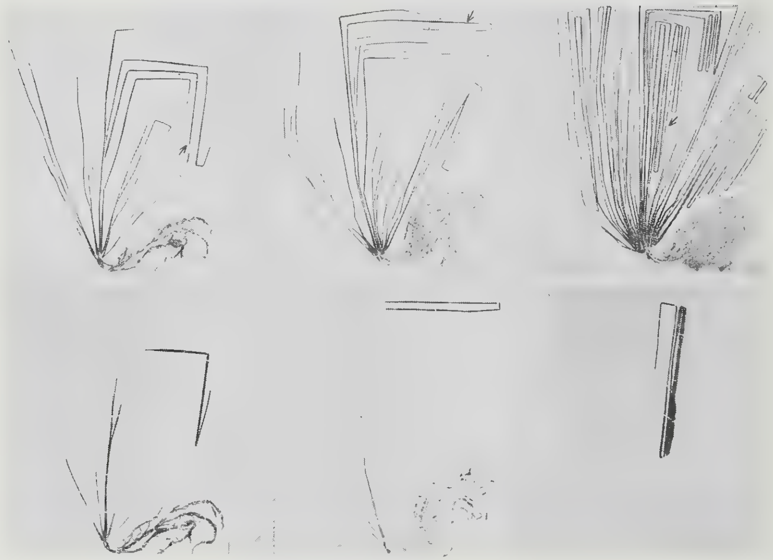
not reveal any significant autoradiographic artefacts which could have influenced the interpretation of the other autoradiographs.

The labelling pattern of plants at the one, two and four-tiller stages (Figs. 3, 4 and 5 respectively) were similar. Carbon-14 assimilates were exported mainly to young developing leaves of the main and daughter tillers and to the roots. In almost all other leaves there was a faint trace of radiocarbon.

A change in the distribution pattern of assimilates occurred at the six-tiller stage of development (Fig. 6). Export of ^{14}C-assimilates to the daughter tillers decreased considerably, although the roots continued to accumulate radiocarbon.

At the eight-tiller stage there was a similar pattern of distribution of ^{14}C-assimilates as at the six-tiller stage.

Export of labelled assimilates from the treated leaf decreased even more at the mature vegetative stage (Fig. 7). Only the roots received assimilates.



FIGS. 5–7

Photographs of mounted plants above, autoradiographs below. Youngest fully expanded leaf on main tiller of plants at the four-tiller stage (Fig. 5), six-tiller stage (Fig. 6) and mature vegetative stage (Fig. 7), treated.

(b) *Treatment of oldest green leaf on main tiller:*

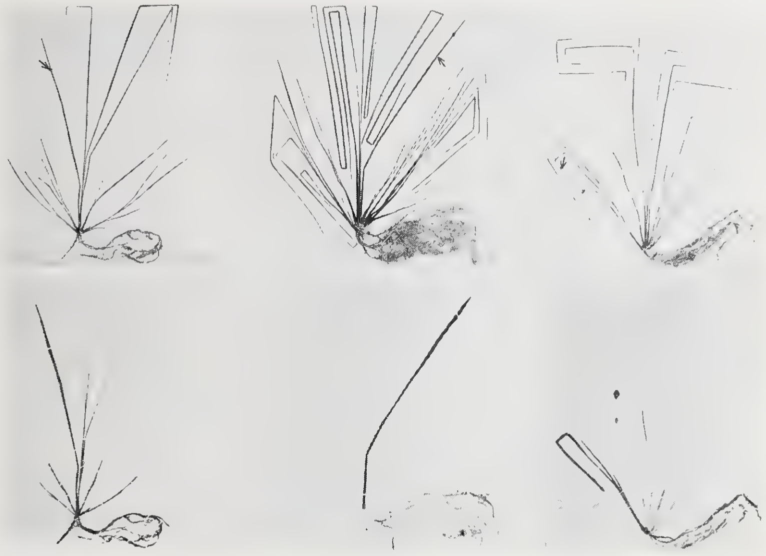
The patterns of distribution of labelled assimilates from the oldest green leaf on the main tiller, were very similar to those from the youngest fully expanded leaf on the main tiller at all vegetative stages of growth, in which treatments were imposed. Only the results for the seedling stage (Fig. 2) and for the four and six-tiller stages (Figs. 8 and 9 respectively), are shown.

Again, ^{14}C-assimilates from the treated leaf were translocated predominantly to young developing leaves of the main and daughter tillers and to the roots in plants up to the four-tiller stage of development.

From the six-tiller stage to the mature vegetative stage export of assimilates to the daughter tillers again decreased considerably although the roots continued to accumulate radiocarbon.

(c) *Treatment of youngest fully expanded leaf on oldest daughter tiller:*

At the two and four-tiller stages labelled material was translocated mainly to young developing leaves of the treated tillers, to the root systems and to a



8 9 10

FIGS. 8–10

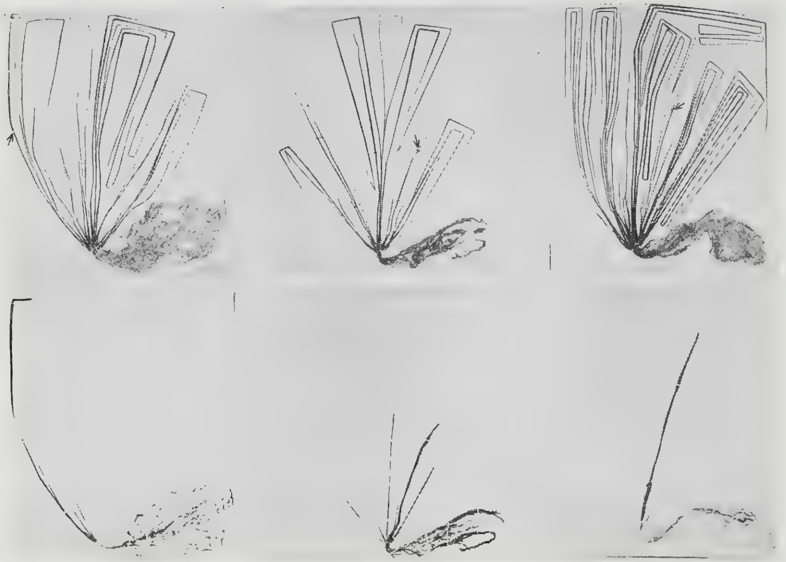
Photographs of mounted plants above, autoradiographs below. Oldest green leaf on main tiller of plants at the four-tiller stage (Fig. 8) and six-tiller stage (Fig. 9), treated. Youngest fully expanded leaf on oldest daughter tiller of a plant at the four-tiller stage (Fig. 10), treated.

lesser extent to growing regions of the main and other daughter tillers. Traces of radioactivity were present in most mature leaves. An autoradiograph of a plant at the four-tiller stage (Fig. 10) only is shown.

Again a change in the distribution pattern of assimilates occurred from the six-tiller stage to the mature vegetative stage. Carbon-14 assimilates from the treated leaves of plants at the six- and eight-tiller stages and the mature vegetative stage, were translocated mainly to growing regions of the treated tillers, to developing leaves of young tillers nearest them and to the roots. It is interesting to note that no assimilates were exported to the main tillers and translocation was restricted only to tillers on the same side as the treated tillers. An autoradiograph of a plant at the six-tiller stage (Fig. 11) only is shown.

(d) *Treatment of youngest fully expanded leaf on youngest daughter tiller:*

The distribution of labelled assimilates at the two and four-tiller stages, was similar to the distribution patterns that were obtained in plants at the same developmental stages, when the youngest fully expanded leaf on the oldest


11 12 13

Figs. 11–13

Photographs of mounted plants above, autoradiographs below. Youngest fully expanded leaf on oldest daughter tiller of a plant at the six-tiller stage (Fig. 11), treated. Youngest fully expanded leaf on youngest daughter tiller of plants at the four-tiller stage (Fig. 12) and eight-tiller stage (Fig. 13), treated.

daughter tiller, was treated. An autoradiograph of a plant at the four-tiller stage (Fig. 12) is shown.

In a plant at the eight-tiller stage of development (Fig. 13) almost all the assimilated carbon was retained by the treated leaf. Some labelled carbon was exported to young developing leaves of the treated tiller and to the roots.

Discussion

The patterns of distribution of labelled assimilates in *Eragrostis curvula* agree generally with findings in other members of the Gramineae in which similar investigations were carried out (Quinlan and Sagar, 1962; Williams, 1964; Sagar and Marshall, 1966; Marshall, 1967). All growing regions which are incapable of sustaining their own carbon requirements for rapid growth, make a demand upon the flow of assimilates from mature leaves. Assimilates, however, do not go indiscriminately to all growing regions. The stage of development and the position and age of the leaf that fixed ^{14}C, influenced the distribution patterns.

During the early stages of growth (the two and four-tiller stages) there was extensive movement of assimilates from the main tiller to the daughter tillers and vice versa. This reciprocal movement has also been reported by other workers. In wheat plants at the two-tiller stage, Quinlan and Sagar (1962), found that the main shoot passed labelled material to the two growing tillers. When these side tillers were treated, the reverse movement took place. Similar observations for reciprocal movement have also been recorded in young plants of *Lolium multiflorum* at the two- and three-tiller stages of development by Sagar and Marshall (1966) and Marshall (1967). Forde (1966a) also reported this phenomenon in *Cynodon dactylon* (L.) Pers. It appears therefore that reciprocal movement between tillers does take place in many grasses and that the stage of development is an important factor which governs this type of movement. This movement seems to be restricted mainly to the young stages of growth when there is a considerable interdependence of the various parts of a tillering grass plant.

During the later stages of growth, from the six-tiller to the mature vegetative stages, intertiller translocation decreased markedly. Although the main tiller continued to supply small amounts of assimilates to growing regions of young tillers closely associated with it, the movement of assimilates from the daughter tillers ceased. Translocation from the daughter tillers was restricted mainly to their own growing regions and to young tillers closely associated with and on the same side as the treated tiller. It appears therefore that in *E. curvula* tillers become increasingly independent from the six-tiller stage onwards.

Tiller independence in other perennial grasses has been attained at about the seven-tiller stage in *Lolium perenne* (Forde, 1966b) and at the four-tiller stage in *L. multiflorum* (Sagar and Marshall, 1966; Marshall, 1967). It is interesting to note that there was extensive intertiller translocation in *E. curvula* at the four-tiller stage. Williams (1964) noted that in *Phleum pratense*, movement of assimilates from one tiller to another did not occur if the tillers were large. Similar observations were made in rice by Shen (1960). Quinlan and Sagar (1962) found that tillers of spring wheat became independent after ear emergence, while in winter wheats, Lupton (1966) found that they became autotrophic earlier.

Williams (1964) suggested that tiller independence may be related to the stage of differentiation of the vascular strands. This led Forde (1966a) to conclude that tiller independence in *C. dactylon* was probably attained only when tillers formed their own nodal roots.

However, evidence for the free movement of ions between tillers throughout the plant, tends to contradict the apparent individuality of the tiller. Troughton (1960) and Marshall (1967) showed that ^{32}P was translocated to the whole of the plant after absorption by a single root of *L. perenne* and *L. multiflorum* respectively. Williams (1960) confirmed this for ^{35}S in *P. pratense*.

In addition, defoliation experiments have added to the controversy. Marshall and Sagar (1965) showed that partial defoliation of tillers in *L. multiflorum* could induce export of assimilates from a normally independent tiller to damaged tillers. These authors therefore suggested that the plant must be regarded physiologically as a whole, in spite of the apparent individuality of the tiller.

The conclusion that can be drawn from these findings is that tillers become independent, once they have developed sufficient leaf area for the supply of all the assimilates needed for their own growth, and have established efficient rooting systems for the absorption of water and mineral salts. Under conditions of stress, probably caused by defoliation or shortage of nutrients, a reintegration of independent tillers is possible.

In the present investigation, faint images of mature leaves appeared on many autoradiographs. Similar observations were made by Hale and Weaver (1962) in the grapevine. Quinlan and Sagar (1962) reported that in wheat, many mature leaves became labelled when a young leaf assimilated $^{14}CO_2$, and Hoshino, Nishimura and Okubo (1964) reported that there was some translocation into old leaves of Ladino clover when a newly opened leaf was treated.

These findings are in contrast to work carried out by other investigators. Thaine, Ovenden and Turner (1959) demonstrated that in soyabean, import into mature leaves was exceptional. Williams (1964) and Sanderson and Sivapalan (1966) observed no significant movement into mature leaves of *P. pratense* and tea plants respectively.

The possibility that the labelling of mature leaves in wheat occurred via the transpiration stream following migration of label from phloem to xylem, as in the case of translocated herbicides, was investigated by Quinlan and Sagar (1962). However, no indication of xylem transference was obtained. In the grapevine, Hale and Weaver (1962) noted that the activity in mature leaves was not present in the veins but was restricted to the intervenal region of the laminae. This observation suggested that radiocarbon probably reached the mature leaves in the gaseous form. Subsequent investigations by these authors, confirmed this. It is possible therefore, that a similar phenomenon was responsible for the labelling of mature leaves in *E. curvula* and probably also in wheat and in Ladino clover. Microautoradiographic evidence to be presented in another paper demonstrates that $^{14}CO_2$ may be distributed within the plant in the gaseous form.

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A QUALITATIVE STUDY OF THE NODULATING ABILITY OF LEGUME SPECIES: LIST 3

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Abstract

184 species of legumes indigenous to Southern Africa were examined for root nodules. Eleven of these (two belonging to the Mimosoideae, seven to the Caesalpinioideae and two to the Papilionatae) were consistently found to be without root nodules. Of the listed species, 141 had apparently not previously been examined for their ability to produce root nodules.

Uittreksel

'N KWALITATIEWE STUDIE VAN DIE VERMOË VAN PEULPLANTSOORTE OM WORTEL-KNOPPIES TE VORM: LYS 3

184 peulplantsoorte wat inheems aan suidelike Afrika is, is vir die aanwesigheid van wortelknoppies ondersoek. Op elf spesies (2 lede van die Mimosoideae, sewe van die Caesalpinioideae en twee van die Papilionatae) is deurgaans geen knoppies aangetref nie. 141 van die gelyste plantsoorte is skynbaar nog nie van te vore vir wortelknoppies ondersoek nie.

Introduction

Apart from reports by Mostert (1955), Grobbelaar et al. (1967) and Grobbelaar and Clarke (1972), little is known about the nodulating ability of the 1 400-odd legume species (Phillips, 1951) that are indigenous to the Republic of South Africa, South West Africa, Botswana, Lesotho and Swaziland.

In an attempt to remedy this state of affairs a long-term survey was initiated at this laboratory some years ago and the present paper presents information obtained since the previous report was published by Grobbelaar and Clarke (1972).

Procedure

The procedure was identical with that published earlier in greater detail (Grobbelaar et al. 1967). Where possible, plants were examined in the field for root nodules. In other cases plants were grown from seed in pots containing nitrogen-poor media and their roots were examined periodically for nodules. If nodules did not form within a reasonable time, the substrate was enriched with *Rhizobium* suspensions from available cultures and/or with soil from the natural habitat of the species when this was possible.

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Annuals which failed to nodulate in at least three consecutive pot trials and perennials which did not nodulate within at least two years, were regarded as not being able to nodulate under local conditions.

In the case of species that were grown from seed in the laboratory, it was generally noted whether the germination was epigeal or hypogeal and whether a plumular hook developed during germination in the dark. Herbarium voucher specimens were prepared of all species tested. The specimens were identified at the Botanical Research Institute, Pretoria and deposited in the herbarium of the Department of General Botany, University of Pretoria.

Prof. and Mrs. Allen of the University of Wisconsin, U.S.A., have been compiling a card index of all available data regarding the nodulation of legumes for many years. The results of the present investigation are therefore regularly transmitted to them and they in turn indicate through personal correspondence whether other reports (published or personal) are available regarding the nodulating ability of the species concerned.

RESULTS AND DISCUSSION

The species on which information is provided are listed in Table 1. The present list contains only species which are indigenous to the Republic of South Africa, South West Africa, Botswana, Lesotho and/or Swaziland.

Of the 184 species listed in Table 1, eleven were consistently found to be without root nodules. Two of these (*Acacia ataxacantha* and *Entada spicata*) belong to the Mimosoideae and apparently were not previously examined for nodulation. Seven of the eleven species from the Caesalpinioideae that were examined consistently lacked root nodules. Of these *Burkea africana*, *Bauhinia kirkii* and *Cassia petersiana* apparently were not previously examined for nodulation. At least one negative report on the nodulation of the other four species was recorded by the Allens previous to the present study. These reports pertained to *Schotia brachypetala*, *Bauhinia tomentosa*, *Cassia tomentosa* and *Cordyla africana*. Only two of the species listed under the Papilionatae were consistently found to be without root nodules. These were *Calpurnia aurea* ssp. *aurea* and *Virgilia divaricata*, neither of which appears to have been examined previously for nodulation. It is instructive to note that of the 184 species listed in Table 1, 141 species apparently were not previously examined for nodulation. Of the 43 species about which the Allens did have earlier reports, it is only our report on *Baphia massaiensis* ssp. *obovata* which does not agree with the earlier reports. In this particular case only one earlier report (unpublished) reached the Allens and this report suggested that *Baphia massaiensis* ssp. *obovata* probably does not normally nodulate.

Of the 46 species for which germination characteristics are provided in Table 1, 43 were found to be epigeal. Of these 26 produced a plumular hook whilst 8 did not. Two of the 3 species that germinated in a hypogeal fashion formed a plumular hook.

TABLE 1.

List of Indigenous Legume species examined for Nodulation.

Plant species[1]	Herbarium specimen number[2]	Nodulation		Germination[5]
		Present study[3]	Allen's records[4]	
MIMOSOIDEAE				
Ingeae Benth.				
Albizia adianthifolia (Schum.) Wight	25287	+c	C	
A. brevifolia Schinz	16941	+c	C	E+
A. forbesii Benth.	16507	+c	C	E+
Acacieae Benth.				
Acacia ataxacantha DC.	16968	−c, f	C	E+
A. borleae Burtt Davy	16914	+c	C	E−
A. erubescens Welw.	17737	+c	C	E−
A. exuvialis Verdoorn	19436	+c	C	E+
A. fleckii Schinz	17420	+c	A	E+
A. gerrardii Benth.	16510	+c	C	E
A. grandicornuta Gesner	17728	+c	C	E+
A. kraussiana Meisn. ex Benth.	19169	+f	C	
A. luederitzii Engl. var. retinens (Sim.) Ross & Brenan	16509	+c	C	E
A. mellei Verdoorn	17436	+c	C	E+
A. nigrescens Oliv.	16216	+c	A	E−
A. permixta Burtt Davy	17735	+c	C	E−
A. rehmanniana Schinz	17734	+c	C	E−
A. senegal (L.) Willd var. leiorhachis Brenan	17725	+c	C	E+
A. senegal (L.) Willd var. rostrata Brenan	17733	+c	C	E+
A. swazica Burtt Davy	17738	+c	C	E−
A. tenuispina Verdoorn	17746	+c	C	E+
A. xanthophloea Benth.	17730	+c	A	E−
Adenanthereae Benth.				
Dichrostachys cinerea (L.) Wight & Arn. ssp. africana Brenan & Brummit var. africana sens. lat.	19168	+c	C	E+
D. cinerea (L.) Wight & Arn. ssp. nyassana (Taub.) Brenan	23755	+c	C	
Piptadenieae Benth.				
Entada spicata (E. Mey.) Druce	16885	−c, f	C	E+
CAESALPINIOIDEAE				
Dimorphandreae Benth.				
Burkea africana Hook.	16232	−c	C	E−
Amherstieae Benth.				
Schotia brachypetala Sond.	16492	−c	B	E+
Bauhinieae Benth.				
Bauhinia kirkii Oliv.	17552	−c	C	
B. tomentosa L.	25652	−c	B	E
Cassieae Benth.				
Cassia biensis (Steyaert) Mendonca & Torre	22819	+f	A	
C. comosa Vogel	20725	+f	A	

Plant species[1]	Herbarium specimen number[2]	Nodulation		Germination[5]
		Present study[3]	Allen's records[4]	
Cassia kirkii Oliv.	19397	+c	C	E
C. petersiana Bolle	16924	−c	C	
C. plumosa (E. Mey.) Vogel	20732	+f	C	
C. tomentosa L.	25660	−c	B	
Swartzieae DC				
Cordyla africana Lour.	23851	−c	B	H
PAPILIONATAE				
Sophoreae Spreng				
Calpurnia aurea (Ait.) Benth. ssp. aurea	20632	−c	C	E−
Virgilia divaricata R. S. Adamson	19365	−c	C	
Baphia massaiensis Taub. ssp. obovata (Schinz.) Brummitt	25841	+c	B	
Podalyrieae Benth.				
Cyclopia falcata (Harv.) Kies	24381	+f	C	
C. genistoides (L.) R. Br.	22953	+f	C	
C. maculata (Andr.) Kies	16597	+f, c	C	E
C. montana Hofm. & Phill.	22907	+f	C	
Podalyria cuneifolia Vent	17743	+c	C	
P. myrtillifolia Willd	16813	+f	C	
Genisteae Bronn.				
Pleiospora cajanifolia Harv.	19191	+f	C	
Lotononis azurea Benth.	23876	+f	C	
L. calycina Benth. var. hirsutissima Duemmer	25304	+f	C	
L. cytisoides Benth.	22964	+c	C	E+
L. depressa Eckl. & Zeyh.	23653	+f	C	
L. divaricata Benth.	24830	+f	C	
L. macrosepala Conr.	25290	+f	C	
L. mucronata Conr.	24831	+f	C	
L. orthorrhiza Conr.	24834	+f	C	
L. platycarpa (Viv.) Pichi—Serm.	23622	+f	C	
L. sericoflora Dümm.	25307	+f	C	
L. stipulosa (Bak. f.) Schreiber	23623	+f	A	
L. tenella Eckl. & Zeyh.	23731	+f	C	
Pearsonia propinqua Duemmer.	16233	+c	C	E+
P. sessilifolia (Harv.) Duemmer ssp. filifolia (Bolus) Polhill	25303	+f	C	
P. sessilifolia (Harv.) Duemmer ssp. marginata (Schinz.) Polhill	27337	+f	C	
Aspalathus angustifolia (Lam.) R. Dahlgr. ssp. angustifolia	23872	+f	C	
A. cinerascens E. Mey.	23608	+f	C	
A. laricifolia Berg. ssp. laricifolia	16984	+f	C	
A. triquetra Thunb.	27225	+f	C	
Buchenroedera lotononoides Scott-Elliot	27336	+c	C	E+
Dichilus pilosus Conr.	17745	+c	C	
Melolobium adenodes Eckl. & Zeyh.	28901	+f	C	
M. obcordatum Harv.	28915	+f	C	
Crotalaria allenii Verdoorn	27334	+f	C	
C. brachycarpa Burtt Davy	23846	+f	C	
C. burkeana Benth.	25253	+f	C	
C. doidgeae Verdoorn	27863	+f	C	
C. dura Wood & Evans	27839	+f	C	
C. erimicola Bak. f.	19428	+c	C	

Plant species[1]	Herbarium specimen number[2]	Nodulation		Germination[5]
		Present study[3]	Allen's records[4]	
Crotalaria hispida Schinz	25282	+f	C	
C. laburnifolia L. ssp. australis (Bak. f.) Polhill	19182	+f	A	
C. maxillaris Klotzsch	25656	+c	A	E+
C. monteiroi Taub. ex Bak. f. var. galpinii Burtt Davy	20639	+c	C	E+
C. natalitia Meisn.	23890	+f	A	
C. ochroleuca G. Don.	19495	+c	A	E
C. pisicarpa Welw.	19380	+f	C	
C. podocarpa DC.	23660	+f	A	
C. recta Steud.	16802	+f	A	
C. schinzii Bak.	19381	+f	C	
C. spartea Baker	20621	+c	C	E
C. vasculosa Wallich	23871	+f	A	
C. virgultalis Burch.	22839	+f	C	
Argyrolobium collinum Eckl. & Zeyh.	23717	+f	C	
A. humile Phillips	23865	+f	C	
A. lancifolium Burtt Davy	22804	+f	C	
A. megarrhizum H. Bol.	27851	+f	C	
A. pilosum Harv.	28906	+f	C	
A. stipulaceum Eckl. & Zeyh.	19172	+f	A	
A. transvaalense Schinz	16795	+f	C	
Loddigesia oxalidifolia (Sims) Phillips	23679	+f	C	E+
Trifolieae Bronn.				
Trifolium africanum Ser. var. africanum	18281	+f	A	
Loteae Benth.				
Lotus discolor E. Mey.	16811	+f	C	
L. hispidus Desf.	17649	+f	A	
Galegeae Bronn.				
Indigofera acutisepala Conrath.	23843	+f	C	
I. adenocarpa E. Mey.	16963	+f	C	
I. costata Guill. & Perr. ssp. gonioides (Hochst. ex Bak.) Gillett	20600	+f	C	
I. costata Guill. & Perr. ssp. macra (E. Mey.) Gillett	19187	+f	C	
I. cuneifolia Eckl. & Zeyh.	23723	+f	C	
I. cylindrica DC.	21676	+c	C	
I. eriocarpa E. Mey.	28357	+f	C	
I. foliosa E. Mey.	24383	+f	C	
I. glaucescens Eckl. & Zeyh.	27341	+f	C	
I. hispida Eckl. & Zeyh.	27342	+c	C	
I. ingrata N. E. Br.	22885	+f	C	
I. longebarbata Engl.	23855	+f	C	
I. mischocarpa Schl.	23709	+f	C	
I. mollicoma N. E. Br.	23733	+f	C	
I. pauxilla N. E. Br.	23875	+f	C	
I. pongolana N. E. Br.	23644	+f	C	
I. ripae N. E. Br.	25300	+f	C	
I. schinzii N. E. Br..	23612	+f	C	
I. sessilifolia DC.	23720	+f	C	
I. sordida Benth.	27223	+f	C	
I. spinescens E. Mey.	23708	+f	C	
I. stricta L. f.	23678	+f	C	
I. subulata Vahl. ex Poir. var. subulata	28362	+f	C	

Plant species[1]	Herbarium specimen number[2]	Nodulation		Germination[5]
		Present study[3]	Allen's records[4]	
Indigofera tinctoria L.	21680	+c	A	E+
I. torulosa E. Mey.	23632	+f	C	
I. velutina E. Mey.	25650	+f	C	
I. vicioides Jaub. & Spach. var. vicioides	19435	+c	A	
Tephrosia aequilata Bak. ssp. australis Brummitt	16933	+f	C	
T. capensis (Jacq.) Pers. var. hirsuta Harv.	28927	+f	C	
T. contorta N. E. Br.	27224	+f	C	
T. cordata Hutch. & Burtt Davy	27227	+f	C	
T. elongata E. Mey. var. elongata	20908	+f	C	
T. elongata E. Mey. var. pubescens Harv.	28383	+f	C	
T. longipes Meisn. var. longipes	23756	+c	A	E+
T. lupinifolia (Burch.) DC.	23842	+f	C	
T. pseudocapitata H. M. Forbes	27833	+f	C	
T. purpurea Pers. ssp. leptostachya (DC.) Brummitt	19450	+c	A	E+
T. rhodesica Bak. f.	23663	+f	A	
T. villosa (L.) Pers.	19430	+c	A	E
T. vogelii Hook. f.	16929	+c	A	
Sesbania cinerascens Welw. ex Bak.	19185	+c	A	E+
S. coerulescens Harms	19189	+c	A	E+
S. sphaerosperma Welw.	19389	+c	C	
S. transvaalensis Gillett	16564	+c	C	
Lessertia affinis Burtt Davy	23700	+f	C	
L. stenoloba E. Mey.	18240	+c	C	
L. stricta Bolus	23857	+c	C	
Hedysareae DC.				
Smithia erubescens (E. Mey.) Bak. f.	19190	+f	C	
Desmodium natalitium Sond.	25659	+f	A	
D. salicifolium DC.	19478	+c	A	
Alysicarpus rugosus (Willd) DC. ssp. perennirufus J. Leonard	25265	+f	C	
Alysicarpus zeyheri Harv.	24374	+f	A	
Dalbergieae Bronn.				
Dalbergia melanoxylon Guill. & Perr.	19163	+f	A	
D. obovata E. Mey.	20737	+f	C	
Lonchocarpus capassa Rolfe	16500	+c	C	
Phaseoleae Bronn.				
Dumasia villosa DC.	16803	+f	C	
Glycine wightii (Wight & Arn.) Verdc. ssp. wightii var. longicauda (Schweinf.) Verdc.	19431	+c	A	E
Neorautanenia amboensis Schinz.	19371	+f	C	
N. ficifolia (Benth. ex Harv.) C. A. Sm.	23841	+f	C	
Erythrina caffra Thunb.	23764	+c	A	
E. lysistemon Hutch.	22478	+c	A	
E. zeyheri Harv.	25842	+c	C	
Canavalia maritima (Aubl.) Thouars	20728	+f	A	
Fagelia bituminosa (L.) DC.	17553	+f	C	
Rhynchosia ciliata (Thunb.) Druce	22871	+f	C	
R. cooperi (Harv. ex Bak. f.) Burtt Davy.	25274	+f	C	
R. longiflora Schinz.	23648	+f	C	
R. minima (L.) DC. var. minima	28925	+f	A	
R. pentheri Schltr. var. hutchinsoniana Burtt Davy	22903	+f	C	

Plant species[1]	Herbarium specimen number[2]	Nodulation		Germination[5]
		Present study[3]	Allen's records[4]	
Rhynchosia sublobata (Schum.) Meikle	22505	+c	C	H+
Eriosema cordatum E. Mey. var. cordatum	19180	+f	C	
Flemingia grahamiana Wight & Arn.	16938	+f	C	
Vigna angustifoliolata Verdc.	21480	+f	C	
V. davyi Bol.	25658	+f	C	
V. decipiens Harv.	25299	+f	C	
V. luteola (Jacq.) Benth.	28361	+f	A	
V. oblongifolia A. Rich.	19429	+c	C	E+
V. retusa Walp.	27836	+f	A	
V. unguiculata (L.) Walp. ssp. dekindtiana (Harms.) Verdc.	25649	+f	C	
Dipogon lignosus (L.) Verdc.	19481	+c	A	H+
Dolichos angustifolius Eckl. & Zeyh.	23707	+f	C	
D. falciformis E. Mey.	25844	+f	C	
D. hastaeformis E. Mey.	23694	+f	C	
D. trilobus L. subsp. transvaalensis Verdc.	16583	+f	A	
Macrotyloma maranguense (Taub. Verdc.)	21492	+f	C	

1. Species are arranged alphabetically within genera. The genera are arranged according to the system of de Dalla Torre & Harms (1963).
2. Voucher specimens are kept in the herbarium of the Dept. of General Botany, University of Pretoria.
3. A "+" indicates that nodulation was observed and a "–" that nodulation was not observed during an observation period of at least two years. Plants studied at the laboratory are indicated by a "c" whereas species examined in the field are indicated by an "f".
4. The letters A, B and C refer to information obtained by private communication from Professor O. N. Allen, Department of Bacteriology, University of Wisconsin, U.S.A.
   A—nodulation previously observed
   B—species investigated previously but nodulation never observed
   C—species apparently not investigated previously for nodulation
5. "E" denotes epigeal and "H" hypogeal germination. The "+" or "–" indicates whether a plumular hook is formed during germination or not.

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ANDREAEA NITIDA HOOK. f. & WILS., A NEW RECORD OF A SOUTHERN HEMISPHERE MOSS FOR AFRICA

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Abstract

Andreaea nitida Hook. f. & Wils., previously known from South America, Tristan da Cunha S. E. Australia, Tasmania, New Zealand, Auckland Islands and New Guinea is recorded from mountain habitats in the south western Cape Province.

Uittreksel

ANDREAEA NITIDA HOOK. f. & WILS., 'N NUWE VINDPLEK VIR 'N MOS IN DIE SUIDELIKE HALFROND VAN AFRIKA

Andreaea nitida Hook. f. & Wils., voorheen bekend van Suid-Amerika, Tristan da Cunha, S. O. Australië, Tasmanië, Nieu-Seeland, Auckland Eilande en Nieu-Guinee, is ook in berg habitatte in die Suidwes-Kaapprovinsie gevind.

Sim (1926) in his "Bryophyta of South Africa" recorded only two species of the dark coloured montane moss genus Andreaea from South Africa. Of these two, the one "costate" species, i.e. with a median longitudinal nerve in the leaf, was *A. subulata* Harv., the type locality of which is Table Mountain on the Cape Peninsula. More recently, the present author (Schelpe 1969) pointed out the existence in South Africa of another "costate" species of Andreaea similar to the temperate South American *A. subenervis* Hook. f. & Wils. and to the New Zealand *A. nitida* Hook. f. & Wils. On the strength of Sainsbury's (1955) description and comments, the present author had ascribed some of the South African material to *A. nitida*, but on the publication of Schultze-Motel's (1970) monograph of the costate species of Andreaea, it became clear that the name *A. nitida* (syn. *A. subenervis*) was applicable to specimens from the mountains of the south western Cape Province enumerated as follows:

CAPE PROVINCE—Cape Peninsula: Table Mountain, Silverstream Ravine, on flat rock wet from dripping water, 3 000 ft., 11.xii.1955, *E. Esterhuysen 25110* (BOL). Ceres: Hex R. Mountains, Roodeberg, rock surface with water trickling over, S. E. aspect, 6 500 ft., 27.xii.1952, *E. Esterhuysen 20964* (BOL). Clanwilliam: Koue Bokkeveld Mountains, Hexberg, on rock in dry rocky watercourse below summit plateau, 5 000 ft., 24.iii.1951, *E. Esterhuysen 18475* (BOL). Ladismith: Swartberg, Toverkop, rock face, seasonal watercourse on cliffs, E. side, 6 500 ft., 16.xii.1956, *E. Esterhuysen 26823* (BOL).

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Tulbagh: Great Winterhoek, rock face on small falls in seasonal watercourse dry in summer, S. aspect, 5 000 ft., 27.i.1957, *E. Esterhuysen 27044* (BOL).

Consequently, these South African records fill a hitherto apparent gap in the Southern Hemisphere distribution of *A. nitida* given by Schultze-Motel (1970) ranging through South America from Colombia through Ecuador to Bolivia, to Tristan da Cunha, south eastern Australia, Tasmania, New Zealand, Auckland Islands and north eastern New Guinea.

Among the costate species of Andreaea in South Africa, *A. nitida* is distinguished by its ovate leaves with a rather broad indistinct nerve, from *A. subulata* which has subulate, nerved leaves from a broader base. Although only recorded by Sim (1926) from Table Mountain, *A. subulata* is now known to occur on a number of the south western Cape mountain ranges (Cedarberg, Great Winterhoek, Matroosberg, Villiershoek, Wemmershoek, Du Toits Kloof, Hottentots Holland and Swartberg), as well as having a wide Southern Hemisphere distribution as indicated by Schultze-Motel (1970) from South America (Colombia to Tierra del Fuego), Falkland Islands, Africa (S. W. Cape mountains and Ruwenzori), Madagascar, Borneo (Mt. Kinabalu), S. E. Australia, Tasmania, New Zealand and its subantarctic islands.

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A SHORT NOTE ON *COMBRETUM EDWARDSII* EXELL

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Abstract

Combretum edwardsii is a liane with interxylary phloem in the secondary xylem. *C. edwardsii* was described by Exell (1968) from sterile material. The type specimen was collected by D. Edwards. Fertile material collected by H. P. van der Schijff is described.

Uittreksel

KORT AANTEKENINGE OOR *COMBRETUM EDWARDSII* EXELL

Combretum edwardsii is 'n liaan met interxilêre floëem in die sekondêre xileem. *C. edwardsii* is deur Exell (1968) van steriele materiaal beskryf. Die tipe monster is deur D. Edwards versamel. Fertiele materiaal versamel deur H. P. van der Schijff word beskryf.

Combretum edwardsii is a woody climber with stalked elliptical opposite leaves. Brown scales are conspicuous on the leaves and both the petioles and young stems are covered with unicellular combretum hairs.

The leaves are bifacial with anomocytic stomata in the abaxial epidermis only. The scales are about 90–100 μm in diameter and the head consists of 9 to 14 marginal cells. The total number of cells of the head varies from 14 to 25 (Fig. 1A). In a longitudinal section the scale consists of a stalk of four cells and a flat multicellular uniseriate head (Fig. 1B).

The anatomy of the stem and root is the same as the general structure of the family Combretaceae with interxylary phloem in the secondary xylem. In the

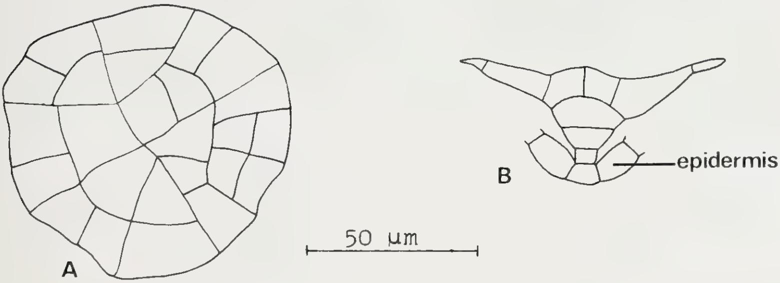

Fig. 1.
Scale of *Combretum edwardsii*. A. Surface view; B. Longitudinal section.

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other three climbers, viz. *C. bracteosum* (Hochst.) Brandis, *C. microphyllum* Klotzsch, and *C. mossambicense* (Kl.) Engl., interxylary phloem is absent. Of all the South African species *Combretum edwardsii* is therefore the only climber with interxylary phloem. The latter three species are also the only South African representatives with stalked glands on the leaves (Verhoeven & Van der Schijff, 1973).

C. edwardsii Exell was described by Exell (1968) from sterile material in the hope that fertile material would be collected at a later stage. The type specimen was collected by D. Edwards (*Edwards 3147*, PRE, holotype). Unfortunately the collecting date was not given.

Material of *C. edwardsii* was collected by R. L. Verhoeven on 6th December, 1968 in Natal, District Impendle about 64 kilometres from Pietermaritzburg on the road to Bulwer. From this material the anatomy of the plant was studied. The species is a definite climber and occurs abundantly in the area.

The first fertile material and so far the only known, was collected by H. P. van der Schijff at Mariepskop in the Eastern Transvaal on the 25th October, 1962. The specimen, viz. *Van der Schijff 6273*, was wrongly identified as *Quisqualis parviflora* Gerr. and was only recently rediscovered and correctly identified as *Combretum edwardsii* Exell.

At Mariepskop it grows as a robust liane with a basal stem diameter of up to 20 cm thick, in dense indigenous mountain forest. It tops the tree stratum and the cream-coloured inflorescences are found in open sunlight on the forest canopy—probably the main reason why fertile material was not collected at an earlier stage.

Inflorescence a spike 3 to 4 cm long; Sepals 4 (3,5 mm); Petals 4 (1,5 mm); Stamens 8 (7–8 mm); Pistil 8,5 to 9,5 mm; Style 5,5 to 6 mm. The unilocular inferior ovary bears at its top a short floral tube. At the top of the floral tube are four sepals. Alternating with the sepals are four petals. The eight stamens are inserted on the floral tube. Interior to the bases of the filaments the floral tube is developed into a lobed hairy disk.

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BATCHELOROMYCES, A NEW GENUS OF ANNELLIDIC DEMATIACEOUS HYPHOMYCETES ON *PROTEA CYNAROIDES* IN SOUTH AFRICA

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Abstract

A description of *Batcheloromyces* Marasas, Van Wyk & Knox-Davies, a new genus of dematiaceous Hyphomycetes is given. The new genus is characterized by mycelial plugs in the stomata and superficial mycelium forming pulvinate radiating plates. The conidiogenous cells (annellides) are calyciform with distinct annellations and one- or two-celled, brown, bacilliform conidia are produced by successive percurrent proliferations of the conidiogenous cells. A single species, *B. proteae* sp. nov. on *Protea cynaroides* L. is included in the genus at present.
The relationships of *Batcheloromyces* with other genera of dematiaceous Hyphomycetes are discussed.

Uittreksel

BATCHELOROMYCES, 'N NUWE GENUS VAN ANNELLIDIESE DONKERKLEURIGE HIFOMISETE OP *PROTEA CYNAROIDES* IN SUID-AFRIKA

Batcheloromyces Marasas, Van Wyk & Knox-Davies, 'n nuwe genus van donkerkleurige Hifomisete word beskryf. Die nuwe genus word gekenmerk deur miseliumproppe in die huidmondjies en oppervlakkige miselium wat kussingvormige miseliumplate vorm. Die konidiogene selle (annellides) is koppievormig met duidelike annellasies en een- of twee-sellige, bruin, bacillusvormige konidiums word deur opeenvolgende proliferasies van die konidiogene sel deur die opening wat gelaat word deur die afskeiding van die vorige konidium, gevorm. Slegs 'n enkele spesie *B. proteae* sp. nov. op *Protea cynaroides* L. word tans in die genus geplaas. Die verwantskappe van *Batcheloromyces* met ander genera van Hifomisete word bespreek.

In the course of an investigation of foliicolous fungi of South African Proteaceae (Van Wyk, 1973), an interesting dematiaceous Hyphomycete was collected on *Protea cynaroides* in the Cape Province. This fungus differs from all the fungi that have been described on Proteaceae and from the known genera of dematiaceous Hyphomycetes (Ellis, 1971). Consequently it is described here as *Batcheloromyces proteae* gen. et sp. nov. The type specimen is deposited in the Mycological Herbarium of the Plant Protection Research Institute, Pretoria, Republic of South Africa (PREM).

Batcheloromyces Marasas, Van Wyk et Knox-Davies gen. nov.

Deuteromycotina, hyphomycetes. *Coloniae* orbiculatae, radiantes, atrae, maculas rufobrunneas efficientes. *Mycelium* partim in stomatibus immersum, partim superficiale, ex hyphis ramosis, septatis, brunneis, ab stromatibus

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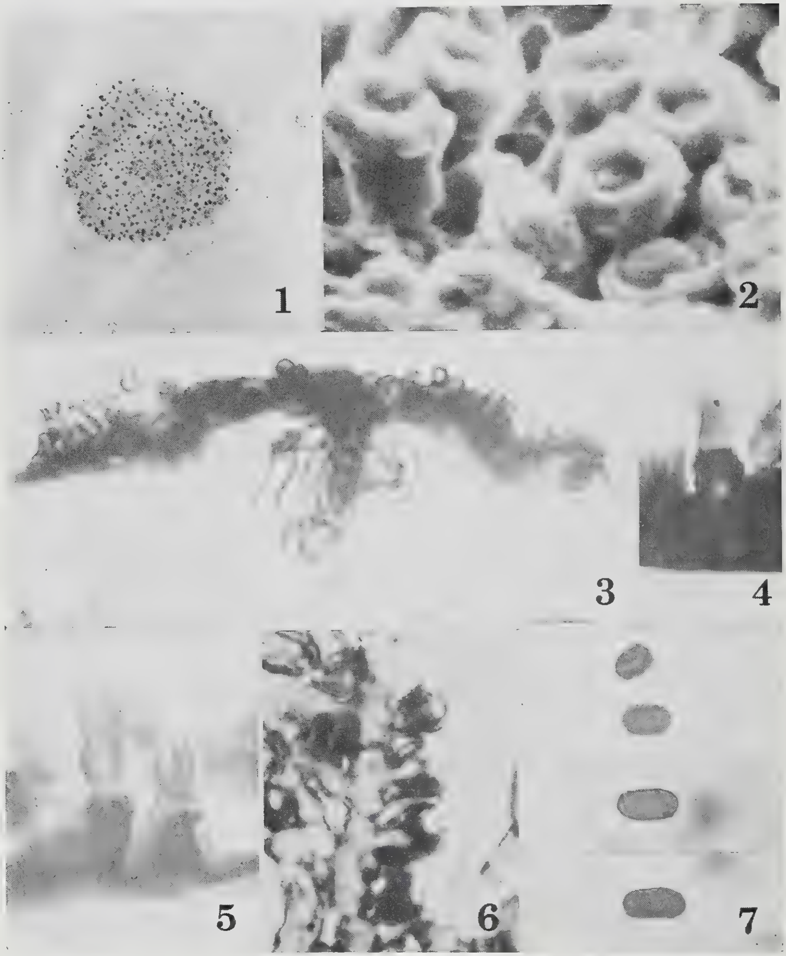

FIGS. 1–7.

Batcheloromyces proteae, type material (PREM 44850). 1, Colony on leaf of *Protea cynaroides* showing the black, pulvinate plates of radiating mycelium, X4; 2, Calyciform conidiogenous cells on superficial mycelium. Uncoated material on leaf examined under a Coates and Welter Model 100–4 field emission scanning electron microscope, X8500; 3, Section through leaf of *P. cynaroides* showing the mycelial plug in the stoma and the superficial plate of radiating mycelium on the leaf surface above the stoma, X900; 4, Annellide with three annellations and an undetached conidium, X2500; 5, Annellides with two successively formed conidia clinging together in false basipetal chains, X2500; 6, Calyciform conidiogenous cells (annellides) produced as lateral erect or ascending branches on the superficial hyphae, X2000; 7, One-celled, brown, bacilliform conida, X1300.

pulvinatis ramosis compositum. *Conidiophora* macronemata, mononemata, simplicia, brunnea, solitaria ex lateribus hypharum oriunda. *Cellae conidiogenae* monoblasticae, in conidiophoris incorporatae, terminales, brunneae, calyciformea, percurrentes. *Conidia* singulatim in apice conidiophori oriunda, solitaria sed interdum in catenis falsis curtis persistentia, sicca, brunnea, crassitunicata, laevia, ellipsoidea vel bacillaria, continua vel uniseptata.

Species typica: Batcheloromyces proteae Marasas, Van Wyk et Knox-Davies

Colonies on leaves circular, radiating, black in colour, causing reddish-brown leaf spots. *Mycelium* in the leaf tissue restricted to the stomata as stromatic mycelial plugs. On the leaf surface the mycelium forms pulvinate, sporodochium-like plates of radiating olivaceous-brown hyphae above the stomata and a network of delicate, branched, septate, superficial hyphae closely adhering to the leaf surface. *Conidiophores* macronematous, mononematous, simple, brown, arising as short, erect or ascending branches of the superficial hyphae, usually composed of a single terminal conidiogenous cell. *Conidiogenous cells* (*annellides*) monoblastic, integrated, terminal, brown, calyciform, percurrent with distinct annellations. *Conidia* arise solitarily as blown-out ends of the apex of the conidiogenous cell, dry, brown, smooth, thick-walled, ellipsoidal or bacilliform with rounded ends or a truncate base and rounded apex, one-celled or with a single transverse septum; conidia produced by successive percurrent proliferations of the conidiogenous cell may hang together in short fragile, false basipetal chains.

Etymology: The genus is named after Mr. F. C. Batchelor of Stellenbosch on whose farm the type species was collected.

Batcheloromyces proteae Marasas, Van Wyk et Knox-Davies sp. nov.

Coloniae amphigenae, usque ad 2 cm diam. *Stromata* superficialia, pulvinata, 110-250 μm diam. Hyphae 2,2-4,2 μm crassae. *Condiophora* effusa sed creberrima in centro coloniae, plerumque ex cella conidiogena una composita. *Cellae conidiogenae* calyciformes, usque ad 3 proliferationes successivas (= annellationes) producentes, 3,0-5,3 μm longae, 3,3-4,8 μm latae ad apicem, 2,2-3,1 μm latae ad basim. *Conidia* solitaria vel usque ad 3 conidia interdum in catenis falsis fragilibus persistentia, brunnea, laevia, crassitunicata, ellipsoidea vel bacillaria, continua vel uniseptata, 3,9-9,1 × 2,8-4,2 μm.

Habitat in foliis vivis *Proteae cynaroides* L., Stellenbosch, Cape Province, Republic of South Africa, 15 viii. 1973, Van Wyk, PREM 44850, holotypus.

Colonies on leaves amphigenous, circular, radiating, up to 2 cm diam, discrete but becoming confluent and covering large areas of leaf surface, black, causing a reddish-brown discolouration of the leaf tissue (Fig. 1) which may be visible in the corresponding areas of the opposite leaf surface. *Mycelium* in the leaf tissue composed of thick, dark brown, stromatic mycelial plugs in the stomata (Fig. 3), but no subcuticular or intra-epidermal mycelium could be seen. The mycelial plugs are erumpent through the stomata and form black, pulvinate, sporodochium-like plates of radiating hyphae above the stomata (Fig. 3) and a network of delicate superficial hyphae closely adhering to the leaf surface. Each colony comprises numerous black superficial mycelial plates, 110-250 μm diam (Fig. 1) and these plates are composed of a single layer of radiating, septate, branched, brown hyphae, 2,2-4,2 μm diam. *Conidiophores* arise solitarily as short, simple, erect or ascending, lateral branches on the superficial hyphae (Fig. 2,6), effuse but concentrated in the centre of the colonies directly above the stomata, usually consisting of a single terminal conidiogenous cell (Fig. 2,6) but sometimes the conidiogenous cell proliferates through the conidial scar to produce a second conidiogenous cell or a hypha which can presumably give rise to a second conidiogenous cell at a higher level. *Conidiogenous cells* (*annellides*) are brown, integrated, terminal, percurrent with up to three annellations (Fig. 4), typically calyciform, 3,0-5,3 μm long, 2,2-3,1 μm diam at the base and widening towards the apex which is 3,3-4,8 μm wide (Fig. 2,6), sometimes doliiform, 3,0-4,6 μm high and 2,3-3,8 μm wide. *Conidia* arising singly as blown-out ends of the apex of the conidiogenous cell (Fig. 4,6), solitary, or conidia produced by successive percurrent proliferations of the conidiogenous cell may hang together in fragile, false basipetal chains of two or three conidia (Fig. 5), dry, brown, oblong-ellipsoidal or bacilliform with both ends rounded or truncate at the base, smooth, thick-walled, one-celled (Fig. 7) or rarely with a single transverse septum and then not constricted at the septum, 3,9-9,1 × 2,8-4,2 μm.

On living leaves of *Protea cynaroides* L., Protea Heights, Devon Valley, Stellenbosch district, Cape Province, 15 August 1973, *Van Wyk* (PREM 44850, holotype).

Specimens examined: CAPE—Protea Heights, Stellenbosch, 15 August 1973, *Van Wyk* (PREM 44850, holotype); Assegaaibos, Jonkershoek, Stellenbosch, 23 August 1972, *Van Wyk* (PREM 44852); Oudebos, Betty's Bay, 15 March 1973, *Van Wyk* (PREM 44851); George, 25 September 1973, *Van Wyk* (PREM 44916).

The annellations on the conidiogenous cells are so conspicuous under the light microscope (Fig. 4) that we can only assume that this fungus belongs in Section III of Hughes' original classification (Hughes, 1953b) and that conidial development is annellidic as defined by the "First International Specialists' Workshop-Conference on Criteria and Terminology in the Classification of Funge Imperfecti" (Kendric, 1971). If this interpretation is in fact correct, *Batcheloromyces* appears to be related to the form-genera *Deightoniella* Hughes, *Pollaccia* Baldacci & Ciferri, *Spilocea* Fries and *Oedothea* Sydow as defined by Hughes (1953a) and Ellis (1971). The vegetative mycelium and calyciform annellides are also similar to those of the genus *Phragmospathula* as described by Subramanian and Nair (1966). The combination of morphological characteristics of the fungus on *P. cynaroides*, i.e. mycelial plugs in the stomata, superficial plates of radiating mycelium, calyciform annellides and brown, thick-walled, bacilliform, one- or two-celled conidia, clearly differetiates it from all these apparently related genera. In the absence of electron microscopic studies of conidium ontogeny, it is not possible to draw final conclusions as to the relationships of *Batcheloromyces* at present.

ACKNOWLEDGEMENTS

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Jl S. Afr. Bot. 41 (1): 47–50 (1975)

PLANTAE NOVAE AFRICANAE

"Ex Africa semper aliquid novi"—Pliny.

SERIES XXXIII

R. H. Compton
(*Compton Herbarium, Kirstenbosch*)

Abstract

Six new species of flowering plants from Swaziland are described.

Uittreksel

Ses nuwe blomplantsoorte vanaf Swaziland word beskryf.

Introduction

The following names and descriptions are given for new species collected in Swaziland and continue the publication in this periodical, vol. 33, pp. 293–304, October 1967. The specimens cited are preserved in the Herbarium of the Botanical Research Institute, Pretoria, and the Compton Herbarium, National Botanic Gardens, Kirstenbosch. My sincere thanks are due to the heads and staffs of these institutions for their invaluable assistance throughout my work on the flora of Swaziland.

Kalanchoe alticola Compton (Crassulaceae).—Herba perennis erecta succulenta glabra, leviter glauca. Folia pauca opposita, in caulis parte inferiore sessilia, ovata, integra, basim contracta, obtusa, marginibus subcoriaceis. Inflorescentia in pedunculo elongato terminalis, dichasio-corymbosa; calycis segmenti acuti; corolla flava, base ventricosa, segmentis patentibus acutis.

Perennial, glabrous throughout. Rhizome horizontal, shallow, elongated, c 5 mm diam., prolonged at apex into erect aerial shoot c 25 cm high, occasionally with lateral shoots also. Shoot bears up to 5 pairs of imbricating somewhat succulent slightly glaucous leaves on its basal half, above which it bears one or two remote pairs of reduced leaves separated by long internodes and ends in a dichasio-corymbose inflorescence c 5 cm diam. Lower leaves sessile, narrowing gradually to base, widest above middle, obtuse, up to 4 cm long × 2 cm wide with entire subcoriaceous margin. Leaves on inflorescence axis similar, up to 1,5 cm long × 1 cm wide. Calyx c 5 mm long, lobes acute. Corolla tube inflated, c 1 cm long, lobes spreading, c 6 mm long, pointed, clear light or deep yellow.

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Hab. Swaziland. Highveld, peaty rock surfaces and crevices. Fl. May–September.

2631 (Mbabane): Mukusini Hills c 1 300 m alt. (-AB), *Compton 32107* (NBG, holotype); *Compton 30437; Karsten s.n.*, 11/5/1963.

Lotononis spicata Compton (Leguminosae).—Caules erecti, dense foliosi, ubique sparse pilosi, pauci. Folia sessilia, trifoliata, segmentis subequalibus erecto-patentis, ovato-lanceolatis, obtusis. Inflorescentia dense spicata, floribus in foliorum superiorum axillis, foliis obtectis. Calycis lobus anterior angustus, superiores minuti, reflexi. Corolla flava; vexillum obtusum, alae angustiores, carina obtusa.

Rhizomatous perennial. Shoots erect, up to 25 cm high, with few branches near base. Stems, leaves and calyces with scattered long fine hairs. Leaves numerous, hiding stem, trifoliate, sessile, erecto-patent, lobes about equal, lanceolate or ovate-lanceolate, entire, obtuse, up to 2 cm long × 7 mm wide, usually less. Flowers borne along upper half of shoot forming a dense spike, shorter than and partly hidden by subtending leaves. Calyx c 5 mm long to the tip of the very narrow anterior lobe, other calyx-lobes very small, reflexed. Corolla yellow, vexillum a little darker, erect, obtuse, c 8 mm long; alae narrow, c 4 mm long; carina obtuse, c 8 mm long.

Hab. Swaziland. Highveld grassland. Fl. March. 2631 (Mbabane): Mpalaleni, c 1 300 m alt. (-AB), *Compton 32111* (NBG, holotype); 3 miles W. of Mankaiana (-CA), c 1 300 m alt. *Compton 28666;* Ngwenya Mts. c 1 650 m alt., *Compton 26737.*

Acalypha moggii Compton. (Euphorbiaceae).—Radix lignosa, perennis. Caules flexuosi, internodiis elongatis, foliis paucis, ubique sparse pilosi. Petiola perlonga; lamina late ovata, acuta, forte cordata, marginibus dentatis. Planta monoecia. Inflorescentiae axillares, inferiores masculae, longe pedunculatae, floribus dense longe spicatis. Inflorescentia feminea lata, haud pedunculata; bracteae latae, laciniatae, imbricatae, floribus obtectis, stigmatis haud productis.

Woody rootstock from which rise single shoots up to 130 cm high, unbranched except near apex. Stem prominently ribbed, sparsely hairy, up to 7 mm diam., internodes up to 10 cm long. Leaves alternate, petiole up to 8 cm long, lamina broadly ovate, up to 8 cm long × 6 cm wide, tapering to narrow point, deeply cordate, margins regularly closely dentate, teeth up to 3 mm long and wide, veins very narrow. Monoecious. Inflorescences axillary, males below, females usually single near apex of shoot, occasionally lower. Male peduncle slender, up to 5 cm long, sometimes with leafy basal bract, flowers very numerous, densely crowded in slender spike up to 7 cm long × 4 mm diam., perianth 2 mm long, hairy, stamens protruding. Female spike clasped at base by small leaves, massive, up to 8 cm long × 2,5 cm diam., usually less;

bracts broad, imbricate, laciniate, acuminate, strongly ribbed, with copious stalked glands; stigmas not evident; capsule c 4 mm diam.

Hab. Highveld swamps. Fl. January–April. 2430 (Acornhoek): Rosehaugh, Pilgrim's Rest, 1 200 m alt. (-DD), *Mogg 13666* (PRE, holotype); Belfast, 2 000 m alt., *Bruce 500.* 2531 (Komatipoort): Piggs Peak, 1 000 m alt. (-CC), *Compton 27625, 30615.*

First collected by Dr. A. O. D. Mogg, 10th January 1938.

Dicliptera divaricata Compton (Acanthaceae).—Caules subrigidi herbacei, ramis numerosis divaricatis, internodiis elongatis. Folia opposita, sparse puberula, breviter petiolata, lanceolata, minute apiculata. Flores paucae in axillis superioribus; corolla pallide purpurea.

Erect, rather stiffly herbaceous, up to c 60 cm high, branching freely at c 45°. Stems slender, prominently 4-ridged, almost or quite glabrous, internodes of main stem up to 10 cm long. Leaves in opposite pairs, spreading or deflexed, very sparsely puberulous throughout; petiole up to 5 mm long; lamina lanceolate, broadest below middle, minutely apiculate, faintly veined, up to 4 cm long × 1 cm wide. Flowers rather few in upper leaf-axils, opening singly; outer bracts c 8 mm long × 2 mm wide, long-attenuate; calyx 4 mm long; bracts and calyx minutely puberulous; corolla mauve, tube c 8 mm long, lobes c 1 cm long; filaments inserted at mouth of corolla, straight, c 8 mm long, anther-lobes roundish borne at different levels.

Hab. Swaziland. Lowveld. Fl. March. 2731 (Louwsberg): Ingwavuma Poort, 100 m alt. (-BB), *Compton 28614* (NBG, holotype); Gollel, 100 m alt. (-BD), *Rubin s.n.*

Lobelia coddii Compton (Campanulaceae).—Planta perennis, fastigiata, caulibus rectis. Folia multa, sessilia, erecto-patentia, mesonevro prominente, marginibus pauco-dentatis. Flores multae in foliarum reductarum axillis, pedicellatae; calyx campanulatus, lobis expansis, angustis, apiculatis; corolla azurea vel variegata, segmentis dorsalibus reflexis, ventralibus expansis.

Tufted perennial, producing a large number of erect straight shoots from a woody rootstock, up to c 45 cm high, sparingly erectly branched near base, more widely branched near apex. Stems and leaves thinly hairy, becoming glabrous with age. Stems with few narrow ribs. Leaves numerous, rather uniform in shape and size throughout, erecto-patent, sessile, lanceolate, with strong midrib, minutely apiculate, margins entire or with one or two forward-directed pointed teeth on each side, up to 8 mm long × 4 mm wide, seldom larger. Flowers numerous, mostly solitary in axils of reduced leaves; pedicel up to 2 cm long; calyx 7 mm long, hairy, campanulate at base, lobes spreading, narrow apiculate; corolla blue, sometimes with yellow blotch, two upper lobes 2 mm long, reflexed on either side of united anthers, three lower lobes expanded, obtuse, c 3 mm long × 2 mm wide.

Hab. Swaziland. Rocky places on mountains. Fl. about March. 2631 (Mbabane): Hills c 3 miles W of Mbabane, rocks, c 1 100 m alt. (-AC), *Compton 25727* (NBG, holotype); Hills c 3 miles W of Mbabane, shallow soil on granite crest c 1 200 m alt., *Codd 9516* (PRE).

Lobelia delicatula Compton (Campanulaceae).—Planta delicatissima. Caules tenues, undulati. Folia alternata, breviter petiolata; lamina late triangulata, obtusa, fragilis, marginibus subcrenulatis; calycis segmenti angusti, acuminati; corolla alba vel pallide azurea.

Very slender annual, sometimes perennating with a short rootstock. Roots few. Stems up to c 15 cm long, undulate, c 1 mm diam., ridged, with few slender erect hairs. Leaves alternate, irregularly spaced on stem; petiole up to 5 mm long; lamina very delicate, equilateral-triangular, up to 1 cm long and wide, base almost straight, sides curved, margins slightly crenulate, apex obtuse, lower surface with a few minute hairs. Upper leaves smaller and narrower with few axillary flowers. Pedicel capillary, up to 2 cm long, flower horizontal becoming erect on withering. Calyx 4 mm long, segments narrow, acuminate. Corolla pale blue or white, c 6 mm long, upper lip c 2 mm shorter than lower which has 3 short lobes c 1 mm wide.

Hab. Swaziland. Highveld, moist peaty soil in shade of rocks or on moist banks in forest shade. Fl. February to April. 2631 (Mbabane): Hill N.E. of Mbabane, c 1 400 m alt. (-AC), *Compton 27538* (NBG, holotype); *Compton 25809;* Black Mbuluzi Falls, c 1 100 m alt. (-AA), *Compton 26852.*

FLORA OF LESOTHO, by A. Jacot Guillarmod, with 474 pages and map of Lesotho on inside cover. Lehre, Germany: J. Cramer. DM150 (R30,85).

Before the publication of the work presently under review, the only treatment of Lesotho plants was E. P. Phillips' "A Contribution to the Flora of the Leribe Plateau and Environs", published in the *Annals of the South African Museum* in 1917. However, his 338 page taxonomic treatment, incorporating descriptions of some new species, included not only the Lesotho collection of Dieterlen and others, but also those from the bordering mountainous areas in Natal, the Orange Free State and the eastern Cape Province.

Since then, Dr. Amy Jacot Guillarmod has collected extensively in Lesotho and has searched European herbaria for specimens collected in that country. The results of her praiseworthy activity both in the field and in herbaria are embodied in the major part of the publication under review. This constitutes a valuable source of information, especially in regard to the location of specimens, but the frequent reference of specimens to an unidentified specific category underlines how much critical taxonomic work on the Lesotho flora still remains to be done.

In addition to interesting sections on Lesotho history, descriptive ecology, land tenure and usage, biographical notes on collectors of Lesotho plants, indices to Lesotho vernacular names and local uses, there is a valuable index of Lesotho place names giving map references. However, despite the wealth of information to be gleaned from this work, the title given to this book, at least to a taxonomist, is rather a misnomer.

E. A. SCHELPE.

TREES OF THE KRUGER NATIONAL PARK, VOL. 2, by P. van Wyk, with pp vi+285–597, 104 full page colour plates. Cape Town: Purnell and Sons, 1974. R17,50.

The second and final volume of Mr. P. van Wyk's *Trees of the Kruger National Park* has now appeared, covering the families Euphorbiaceae to Compositae in the Engler system. It follows the same format and style as the previous volume and one cannot but express satisfaction that the high standards of colour reproduction that characterised the plates in volume I, continue to be maintained. To photograph a mature tree in the lowveld environment, showing its characteristic adult growth form, without being obscured by the associated vegetation, and to present it as a glamorous illustration, requires a skilful balancing of priorities, not to mention the arduous footslogging involved in seeking out photogenic specimens. In the case of novelties like *Steganotaenia araliacea*, *Hymenodictyum parvifolium* and numerous others, it is more than likely that Pieter van Wyk's photographs are the first colour illustrations of these species ever published.

Clearly, the author has made a great effort to keep one step ahead of that apparently invincible monster—Nomenclatural Change. He has succeeded insofar as it is ever possible to be up to date with one's nomenclature and provides the reader with the most recent name changes as well as the latest taxonomic decisions for the Kruger Park tree flora. New records for the Kruger Park, too recent for inclusion in the format of the main text, are also listed. In addition to an index of scientific names with full author citations, there is an index of common names in English, Afrikaans and eight Bantu languages. Regrettably, the chapter headings of these two indexes have been transposed. Several other careless slips in major headings (*Glusiaceae* for *Clusiaceae*) are irksome but not serious. They could surely have been corrected by the publishers.

Many readers will, I am sure, be gratified to learn that the author has adopted a conservative approach as to what constitutes a tree. He has omitted a number of shrubby plants whose growth forms or stature have been either inflated or etiolated by some authorities in order to accord them tree status in the latest edition of the National List of Trees. His sane approach is to be greatly commended. (cf. the note under Myrsinaceae).

It must be stressed that these two volumes are not field guides, to be toted along when motoring through the Kruger Park. Notwithstanding their durable bindings, they are books for the library to be consulted and enjoyed at leisure. Each volume is priced at R17,50. The reader can be assured that by present day standards, this represents a bargain, not easily equalled.

J. P. ROURKE.

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Jl S. Afr. Bot. 41 (2): 53–62 (1975)

NOTES ON *PROTEA* IN SOUTH AFRICA: THE *PROTEA TENAX* TANGLE

J. P. Rourke
(*Compton Herbarium, Kirstenbosch*)

ABSTRACT

The correct usage of the name *Protea tenax* (Salisb.) R. Br. is indicated and the variability of this species is discussed. The taxon previously referred to as *P. tenax* (Salisb.) R.Br. var. *latifolia* Meisn., is accorded specific rank and redescribed as *P. foliosa* Rourke.

UITTREKSEL

AANTEKENINGE OOR *PROTEA* IN SUID-AFRIKA: DIE *PROTEA TENAX* VERWARRING

Die korrekte gebruik van die naam *Protea tenax* (Salisb.) R.Br. word aangedui en die veranderlikheid van die soort bespreek. Die takson voorheen bekend as *P. tenax* (Salisb.) R. Br. var. *latifolia* Meisn., word verhef tot 'n soort en herbeskryf as *P. foliosa* Rourke.

INTRODUCTION

Protea tenax (Salisb.) R.Br. as construed by Phillips and Stapf (1912), contained two elements: a decumbent narrow leaved form and an erect, shrubby broad leaved form, the latter being referred to as *Protea tenax* (Salisb.) R.Br. var. *latifolia* Meisn. Due to the citation of only one specimen of the decumbent narrow leaved form and the citation of numerous collections of the erect, broad leaved form in their account of *Protea tenax* in the *Flora Capensis*, the name *P. tenax* came to be associated with the erect, broad leaved form in most herbaria. The position was not improved by the erroneous citation of a Niven collection of the decumbent narrow leaved form of *P. tenax* under *Protea canaliculata* Andr. resulting in the association of the name *P. canaliculata* with material that should have been referred to *P. tenax*.

A careful study of the type material of all the names involved as well as several years of field work, have now clarified the position. This note is an attempt to clear up the confusion of the past and to define the taxa in question, preparatory to publishing a revision of *Protea* in South Africa.

DISCUSSION

Field studies revealed that two series of allopatric populations are involved which can easily be distinguished by differences in growth habit.

1. From van Stadensberg eastwards to Grahamstown, a relatively uniform taxon occurs, having a shrubby growth habit with erect, usually unbranched

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stems to 1,5 m in height, very prominent, lanceolate, oblanceolate or elliptic leaves and small globose inflorescences. In most herbaria, material of this taxon has been named *P. tenax* (Salisb.) R.Br. but a comparison with the type illustration (*Paradisus Londinensis* tab. 70), clearly shows that it is not *P. tenax*. Although recognized as different and described by Meisner as *P. tenax* (Salisb.) R.Br. var. *latifolia* Meisn. this taxon must be accorded specific rank on the basis of its distinct morphology and geographical isolation. However, it is not possible to raise Meisner's epithet to specific rank since this step would involve the creation of a homonym. It is therefore described *de novo* as *Protea foliosa.*

Protea foliosa Rourke, sp. nov.

A species cognatae differt, propter habitu erecto fruticoso, caulibus erectis non ramosis, foliis prominentibus glabris, lanceolatis vel late ellipticis, inflorescentias cingentes.

Frutex parvus, rotundatus, 1,5 m altus, caulibus numerosus rectus, caudicibus exorientes. *Caules* recti, non ramosi (tantum raro ramosi), glabri, 6–8 mm in diam. *Folia* lanceolata, oblanceolata vel late elliptica, 9–16 cm longa, 1,5–7 cm lata, obtusa vel acuta; glabra, sed pubescentia initio. *Inflorescentiae* ovoideae vel globosae, cyathiformes, 3–4 cm in diam., reconditae, foliis amplis superantibus. *Receptaculum involucrale* 1,5 cm in diam., late convexum. *Bracteae involucrales* 4–5 seriata. Series intima oblonga spathulata, 3–3,5 cm longa, 1 cm lata, apices rotundatos concavos. Series externa ovata vel late ovata, obtusa, 0,7–1,5 cm longa, 0,7–1,2 cm lata; pagina externa sparsa sericea, glabrescens, viridiflava, sordida-carmina suffusa. *Perianthium* 2,5–3 cm longum, glabrum, praeter perianthium limbum manifeste lanatum ad apicem. Perianthium limbi lineares, acuminati, glabri sed apices dense lanatos. *Stylus* 2,5 cm longus, arcuatus adaxialis, contractus terminalis. *Stigma* peranguste lineare, 5 mm longum, compressum, longistrorsum sulcatum. *Squamulae* hypogynae ovatae, acutae, 1,5 mm longae.

A rounded shrub to 1,5 m tall with numerous straight, erect stems arising from a woody subterranean rootstock. *Stems* stout, 6–8 mm in diam., erect, glabrous, rarely branched. *Leaves* lanceolate, oblanceolate or broadly elliptic, 9–16 cm long, 1,5–7 cm broad, narrowed in the petiolar region; apex acute to obtuse; margins occasionally undulate; coriaceous, surface minutely granulate, pubescent at first, soon glabrous. *Inflorescences* ovoid to globose, cyathiform, 3–4 cm wide hidden by large overtopping leaves; terminal but occasionally axillary. *Involucral receptacle* broadly convex, 1,5 cm in diam. *Involucral bracts* 4–5 seriate; innermost series oblong-spathulate 3–3,5 cm long, 1 cm wide, apex broadly obtuse, concave; outer series ovate to broadly ovate, obtuse, 0,7–1,5 cm long, 0,7–1,2 cm wide; outer surface minutely fimbriate; usually greenish yellow, occasionally flushed with dull carmine, particularly along margins. *Perianth*

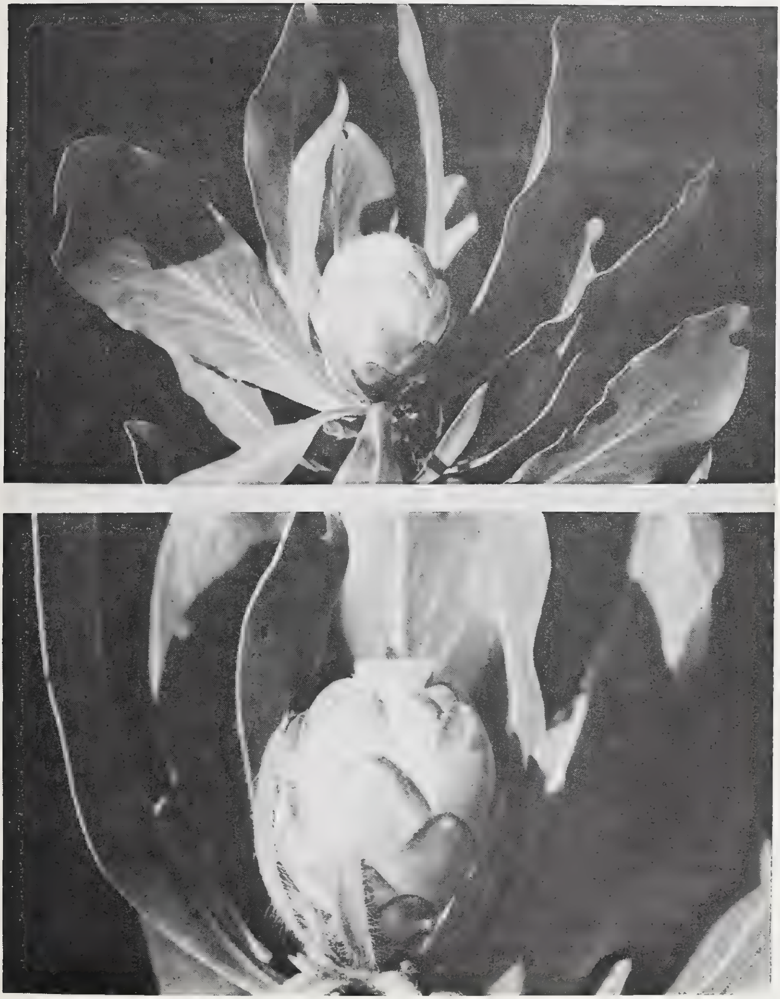

FIG. 1.
Protea foliosa Rourke, part of the type material, *Rourke* 1410. Above: flowering shoot, x 0,5.
Below: inflorescence at anthesis, life size.

straight to very slightly adaxially arcuate, 2,5–3 cm long; tube 8–10 mm long, glabrous; claws slender with strongly undulate margins, glabrous; limbs 8–10 mm long, linear, apices acuminate, glabrescent to glabrous for greater part of their length but apex thickly lanate with a white or brown indumentum. *Style* 2,5 cm long, straight to slightly adaxially curved. *Pollen presenter* linear, acute, 5 mm long. *Ovary* obovoid, 3–4 mm long covered with long tawny trichomes. *Hypogynous scales* ovate acute, 1,5 mm long.

Protea magnolifolia Buek in Drège, Zwei Pfl. Doc.: 118; 127; 213 (1843)—nom. nud.
Protea caulescens E. Mey. ex Meisn. in DC., Prodr. **14:** 244 (1856)—nom. nud.
Protea tenax (Salisb.) R.Br. var. *latifolia* Meisn. in DC., Prodr. **14:** 244 (1856); Phill. & Stapf in Fl. Cap. **5:** 587 (1912). Type: Circa Galgebosch et van Stadensberg, *Drège s.n.* in herb. Meisn. (NY, holo.!).

Two manuscript names, *P. magnolifolia* and *P. caulescens* have been applied to this species but both are *nomina nuda*. The varietal epithet, *P. tenax* (Salisb.) R.Br. var. *latifolia* Meisn. cannot be raised to specific rank as it would then become a homonym of *P. latifolia* R.Br. Since there is no legitimate specific epithet available for this species, it is here described *de novo*.

Type Material: Van Stadensberg Forest Reserve, between Loerie and Otterford, 18.6.1974, *J. P. Rourke 1410* (NBG holo.; PRE, STE, BOL, GRA, K, MO, S, M, C, iso.).

Diagnostic Characters: P. foliosa may be distinguished from related species on account of its shrubby, upright growth habit with erect, unbranched (or only very rarely branched) stems, and prominent glabrous leaves, lanceolate to broadly elliptic, which completely surround the small globose inflorescences.

Common in the Van Stadensberg mountains generally at elevations above 150 m, this species is also found on most Table Mountain Sandstone outcroppings around Uitenhage and Port Elizabeth. Other populations also occur in the fynbos on the hills around Riebeeck East and Grahamstown at elevations of up to 600 m, on soils derived from Witteberg Quartzite. The distribution range of *P. foliosa* falls within a region experiencing a mean annual rainfall of about 500–750 mm, distributed more or less evenly throughout the year but with a slight winter maximum. Flowering takes place erratically between March and September with the peak of the season being in May and June. However, odd inflorescences may be produced at almost any time of the year. A massive woody rootstock or lignotuber gives *P. foliosa* a high degree of fire resistance.

SPECIMENS EXAMINED

CAPE PROVINCE—3324 (Steytlerville): Assagaybosch (-CD), May, *Zeyher 3667* (SAM, GRA).

—— 3325 (Port Elizabeth): Mountains N.W. of Uitenhage (-CB), Aug., *Loots s.n.* (NBG *19425*); Van Stadensberg and Galgenbosch (-CC), 27.12.1829, *Drège s.n.* (P, SAM); Van Stadens, 6.5.1934, *Long 1272* (PRE, GRA, RU, K); Van Stadensberg forest reserve between Loerie and Otterford, 18.6.1974, *Rourke 1410* (NBG, PRE, STE, GRA, K, M, MO, S, BOL, C); Van Stadensberg, Oct.–Nov., *Zeyher 388* (SAM, PRE); Van Stadensberg next to Galgebosch, 14.2.1814, *Burchell 4755* (K); 25 km up the Elands River road (-CD), 3.8.1960, *Acocks 21265* (NBG, PRE); Kamehs, Uitenhage, May, *Paterson 142* (BOL, GRA); 10 km west of Port Elizabeth (-DC), May, *Crump s.n.* (NBG *82, 485*); Bethelsdorp, near Port Elizabeth July, *L. Bolus s.n.* (NBG *82486*); Bethelsdorp Kloof, Aug., *Fries, Norlindh & Weimark 240* (S, NBG).

—— 3326 (Grahamstown): Rocky mountains, Zwartbergen, Albany (-AA), *Burchell 3436* (K); Between Riebeeck East and Grahamstown (-AB), July 1813, *Burchell 3508* (K); Near Coldstream, Grahamstown (-BC), June, *Pym 1174* (SAM, GRA); Prope Grahamstown, *Mac Owan 1266* (BOL); Bottom of Signal

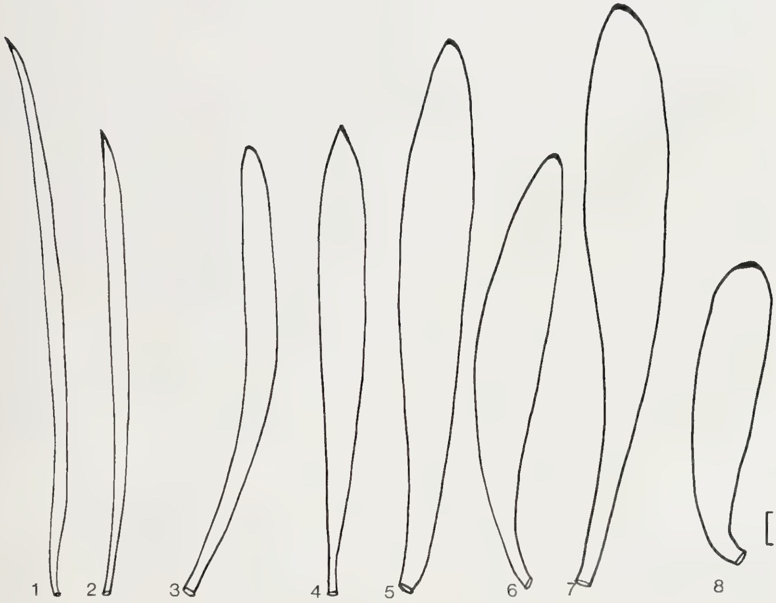

FIG. 2.
Protea tenax (Salisb.) R.Br., showing variation in the leaf morphology.
(1) *Rourke* 908; (2) *Williams* 1782; (3) *Wurts* 2081; (4) *Rycroft* 2336; (5) *Oliver* 4539; (6) *Taylor* 936; (7) *Rycroft* 2336; (8) *L. Abel s.n.* (NBG 62889). The scale line represents 1 cm.

Hill, Grahamstown, Aug., *Daly & Sole 473* (GRA, K); Grassy mountains, Grahamstown, *Galpin 26* (GRA); Featherstone Kloof, north side Grahamstown, 13.6.1963, *Noel 433* (RU); Beggars Bush, *P. Coetzee s.n.* (GRA *1173*); Mountain drive Grahamstown, Aug. 1926, *L. L. Britten 5424* (PRE); Paynes farm, Bushmans River Poort, Alexandria (-CB); 31.8.1954, *Archibald 5624* (PRE, K).

2. The second series of populations ranges throughout the entire length ot the Longkloof on the north slopes of the Outeniqua mountains, from Waboomskraal in the west to Humansdorp in the east and also occurs in the Baviaanskloof and Winterhoek mountains. All are characterised by having decumbent, trailing stems, often with secund or subsecund leaves and greenish-white, shallowly crateriform inflorescences, occasionally flushed with pink. On close examination, little variation in the dimensions or morphology of the inflorescences and floral parts is observable but marked differences in foliar characters give each population a distinctive facies. Considering the variety of habitats occupied, this variation is not surprising. Habitats vary from arid fynbos on hot north facing slopes where the mean annual rainfall is ± 300 mm, to fairly dense sclerophyll in moist sheltered localities where the mean annual rainfall is ± 770 mm.

Leaf width is the only significant variable within this series of populations. Populations occupying drier habitats tend to have narrow, linear, slightly glaucous leaves while populations with broader, elliptic or oblanceolate leaves, having little or no glaucescence, are found on moister sites. However, no satisfactory correlation between geographical distribution and leaf dimensions can be found. In general, the narrow leaved populations display very little range in leaf width but in the broader leaved populations the range in leaf width, even on a single flowering shoot, is considerable (Fig. 3). At first sight, the narrow leaved forms do appear to constitute a distinct group but their random occurrence among broader leaved populations as well as the continuous variation in leaf width (Figs. 2 & 3) makes the recognition of two taxa unwise, even at subspecific rank. *Protea tenax* (Salisb.) R.Br., the earliest legitimate epithet available for this species is typified by a fine colour plate depicting a specimen which most closely resembles a population growing in the vicinity of Kareedouw, eastern Longkloof.

Protea tenax (Salisb.) R.Br. in Trans. Linn. Soc. Lond. **10:** 88 (1810); Meisn. in DC., Prodr. **14:** 244 (1856); Phill. & Stapf in Fl. Cap. **5:** 587 (1912).
Erodendrum tenax Salisb., Parad. Lond. t. 70 (1807). Type: Plate 70 in Parad. Lond.
Protea longifolia Salisb., Parad. Lond. t. 37 (1806), non *P. longifolia* Andr. (1801). Type: Plate 37 in Parad. Lond.
Erodendrum longifolium (Salisb.) Salisb. ex Knight, Cult. Prot.: 46 (1809).

Erodendrum foetidum Salisb. ex Knight in Knight, Cult. Prot.: 46 (1809)—nom. superfl. Type: As for *Erodendrum tenax* Salisb.

Protea canaliculata sensu R.Br. in Trans. Linn. Soc. Lond. **10:** 88 (1810); sensu Meisn. in DC., Prodr. **14:** 241 (1856); et sensu Phill. & Stapf in Fl. Cap. **5:** 591 (1912)—all according to specimens cited,—non *P. canaliculata Andr.*

Protea undulata Phill. in Kew Bull **1910:** 233 (1910). Type: Without collector or locality (K, holo.!)

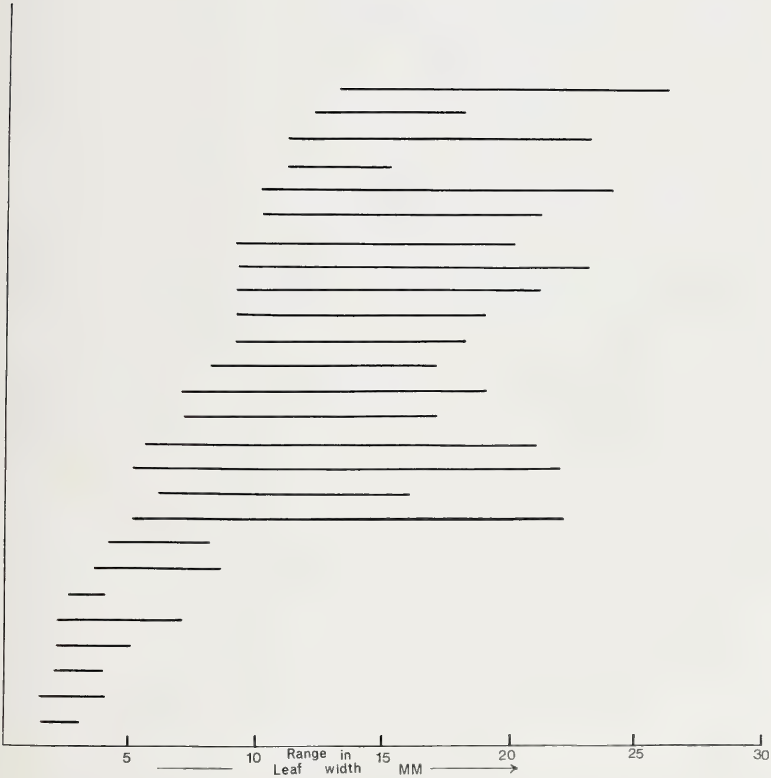

FIG. 3.

Continuous variation in the leaf width of *Protea tenax* (Salisb.) R.Br. (from 26 herbarium collections). Each horizontal stroke represents a single collection, showing the range in leaf width in that collection. This range is plotted by taking the widths of the broadest and narrowest leaves of each collection and linking these two points with a horizontal stroke.

Protea acaulos (L.) Reich. var. *cockscombensis* Archibald in Flower. Pl. Afr. **28** t. 1115 (1951). Type: The Cockscomb, Winterhoek mts., *Archibald 3435* (PRE, holo.!; NBG, GRA, iso.!)

A low decumbent shrub with trailing, sparsely branched stems arising from a woody rootstock. *Stems* to 2 m in length, usually trailing, occasionally suberect, 3–6 mm in diam., puberulous at first, soon quite glabrous, usually flushed with carmine. *Leaves* linear, narrowly lanceolate to lanceolate, elliptic or oblanceolate, 8–18 cm long 2–28 mm wide, apices acute to obtuse; slightly twisted and decurrent at base; lamina flat or only occasionally with incurved margins. *Inflorescences* shallowly crateriform, opening widely, 4–6 cm in diam. *Involucral receptacle* broadly convex, 1,5–2 cm in diam. *Involucral bracts* 4–5 seriate; innermost series broadly oblong, obtuse, 3,5–4 cm long, 1–1,5 cm wide, the apices concave and rounded; outer series very broadly ovate 1–2 cm long, 1–2 cm wide, apices obtuse to rounded; outer surface sparsely sericeous becoming irregularly glabrous, margins minutely fimbriate; bracts greenish-yellow, sometimes flushed with carmine. *Perianth* straight to slightly adaxially arcuate, 2,5–3 cm long, glabrous except for the lanate apices of the perianth limbs; tube 8 mm long; claws hyaline, undulate; limbs 8 mm long, linear, apices acuminate, thickly lanate with a dense white indumentum. *Style* 2,5–3 cm long, straight to slightly adaxially curved. *Pollen presenter* linear, acute, 5 mm long. *Hypogynous scales* irregularly ovate, 1 mm long.

Diagnostic Characters: The decumbent growth habit with trailing stems bearing leaves which are usually secund or subsecund (very rarely ascending) and wide, shallowly crateriform inflorescences, 4–6 cm across the mouth when open, distinguish *P. tenax* from related species.

Populations which are here assigned to *P. tenax* occur throughout the Langkloof, on the Outeniqua, Baviaanskloof, Humansdorp and Groot Winterhoek mountains. Waboomskraal in the Outeniqua range and the Cockscomb near Uitenhage, are, respectively, the extreme westerly and easterly points of its distribution range. Ecologically, the habitats of *P. tenax* may range from arid fynbos where the mean annual rainfall is about 300 mm, to fairly dense fynbos where the mean annual rainfall is about 770 mm. At all localities it is confined to soils derived from Table Mountain Sandstone. Its altitudinal range extends from 250–1 750 m. Flowering is erratic but appears to be correlated with rainfall, which, although it is spread more or less evenly throughout the year within the distribution area of *P. tenax*, tends to have a slight winter maximum. Most of the inflorescences are produced between May and September although they can appear at almost any time of the year.

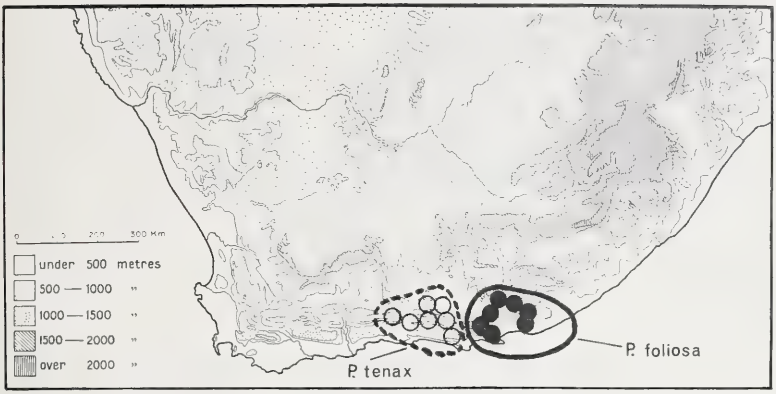

FIG. 4.
Distribution ranges of *Protea tenax* (Salisb.) R.Br. and *P. foliosa* Rourke.

SPECIMENS EXAMINED

CAPE PROVINCE—3322 (Oudtshoorn): Waboomskraal near top of Outeniqua Pass (-CD), 18.7.1954, *Rycroft 1628* (NBG); Summit of old Duivels Kop Pass (-DC), 21.9.1967, *Rourke 908* (NBG).

—— 3323 (Willowmore): Potjiesrivierhoogte, Uniondale (-CA), *Rourke 363* (NBG); Potjiesrivierhoogte Pass, 14.8.1960, *Acocks 21411* (PRE, NBG); 12 km S.W. of Uniondale on fynbos hills, 3.9.1951, *Acocks 16026* (PRE); Rocky hill near Haarlem (-DB), 14.3.1814; *Burchell 4977* (K); Walletjies, between Misgund and Joubertina, Longkloof (-DC), 10.7.1974, *Bayliss 6417* (NBG); Louterwater, 3.5.1933, *Compton 4211* (BOL); North slopes Tsitsikamma State Forest "The Heights", near Joubertina (-DD), 8.6.73, *Kruger 1621* (STE).

—— 3324 (Steytlerville): Baviaanskloof Pass (-CB), 19.5.1971, *Stayner s.n.* (NBG *92541*); Pisgoedvlakte, summit of Cambria Pass, Baviaanskloof, 13.4.1973, *Williams 1782* (NBG); About 0,5 km north of Kareedouw village (-CD), 2.5.1960, *Wurts 2081* (NBG); 3 km from National Rd., on Kareedouw Pass to Assegaai Bosch, 2.5.1960, *Wurts 2078* (NBG); Kareedouw Pass, 28.10.1961, *Rycroft 2336* (NBG); Summit of Pass north of Assegaai Bosch 25.3.1966, *Williams 721* (NBG); Baviaanskloof Mts., above Couties Kraal, N.W. of Cambria (-DA), 12.9.1973, *Oliver 4539* (STE); North slopes of Cockscomb (-DB), 7.10.1962, *L. Abel s.n.* (NBG *62889*); Mac, Groot Winterhoek, 23.9.1953, *H. C. Taylor 936* (NBG); The Cockscomb, Winterhoek mts., *Archibald 3435* (PRE, GRA, NBG); The Cockscomb, 6.9.1954, *Noel 434* (GRA); Rietvlei, Humansdorp (-DC), 11.11.1941, *Esterhuysen 6623* (BOL).

—— 3424 (Humansdorp): 28 km beyond Humansdorp on way to Clarkson (-AB), *C. F. Hayes s.n.* (GRA); Sandy soil on plains at Kromme River (-BA), *Niven 34* (K).

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Jl S. Afr. Bot. 41 (2): 63–66 (1975)

IDENTIFICATION OF ALLANTOIN IN *PROTEA COMPACTA* SEED

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Abstract

By means of I.R., N.M.R. and mass spectrometry it was shown that on a dry mass basis approximately two per cent of *Protea compacta* seed consists of allantoin.

Uittreksel

IDENTIFIKASIE VAN ALLANTOIN IN *PROTEA COMPACTA* SAAD

Deur middel van I.R., K.M.R. en massaspektrometrie is vasgestel dat op 'n droë massa basis ongeveer twee persent van die saad van *Protea compacta* uit allontoïen bestaan.

Introduction

While investigating the effect of endogenous hormones on the germination of *Protea compacta* seed (Brown and Van Staden, 1973) it was observed that concentrated ethanolic extracts of embryo material, when stored at 5 °C, yielded large quantities of needle-like crystals. On a dry weight basis the embryos contained approximately two per cent of this crystalline material. The crystals were insoluble in practically all organic solvents and only slightly so in water. They did, however, dissolve in hot water but crystallised rapidly upon cooling.

Due to the relative abundance of the crystalline substance and the fact that it may play an important role in the physiology of the seed, its identification was undertaken.

Material and Methods

Embryo material of *Protea compacta* R.Br. was homogenized with 80% ethanol, using approximately 25 ml of ethanol per gramme dry mass of material, and was then shaken for 24 hours at 18 °C. After filtering the extract in a Buchner funnel, the residue was thoroughly washed with 80% ethanol. The combined ethanolic filtrates were concentrated to a small volume under vacuum at 35 °C. The concentrated extract was kept at 5° C for 48 hours during which period fine needle-like crystals formed. These crystals were recovered by filtration, purified by recrystallization from water and subsequently used for chemical identification. The crystalline material was optically inactive.

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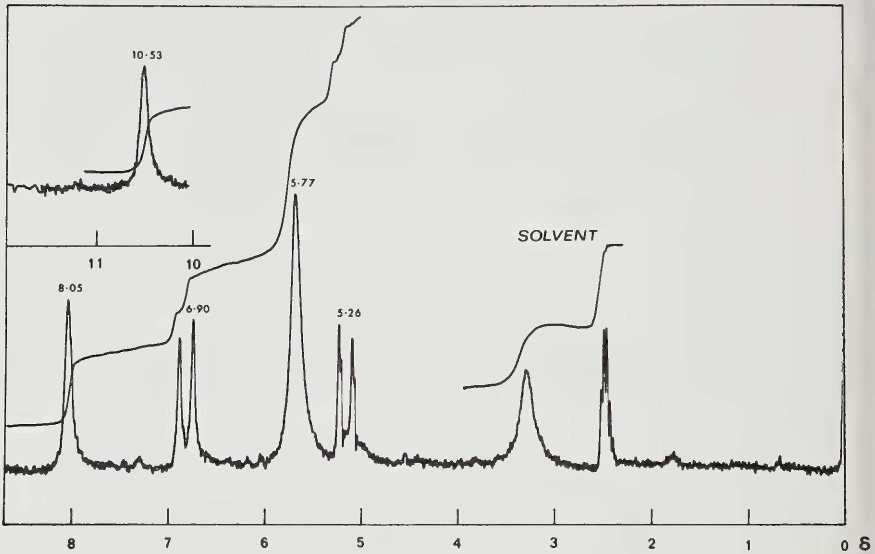

Fig. 1.
N.M.R. spectrum of crystalline compound from *Protea compacta* in $(CD_3)_2$ SO.

Infra-red spectra were run as KBr discs, N.M.R. spectra were recorded on a Varian T60 instrument while a Varian CH7 instrument was used for mass spectrometry.

Results

Using the above procedure every gramme of dry embryo material yielded 17 mg of a relatively pure crystalline compound which had a melting point of 235 °C. In water this substance showed no UV-absorption above 280 nm. Infra-red spectral analysis yielded the following significant data: $\upsilon_{\text{-nu}}$ max 3438, 3340 (NH): 1780, 1705 (CO). The N.M.R. spectrum in $(CD_3)_2$ SO gives rise to:

(i) a singlet at δ 10.53 (single proton -CO-N*H*-CO-),
(ii) a singlet at δ 8.05 (single proton -HC-N*H*-CO-),
(iii) a doublet at δ 6.90 (single proton -CH-N*H*-CONH$_2$),
(iv) a singlet at δ 5.77 (two protons -CON*H*$_2$), and
(v) a quartet at δ 5.26 (single proton -NH-C*H*-NH) (Fig. 1).

Low-resolution mass spectrometry of the unknown compound indicated a molecular ion of m/e 158. Major peaks were recorded at m/e 141 (M-17), 130 (M-CO), 115 (M-CONH), 87 (base peak), 60, 44 and 54 (Fig. 2).

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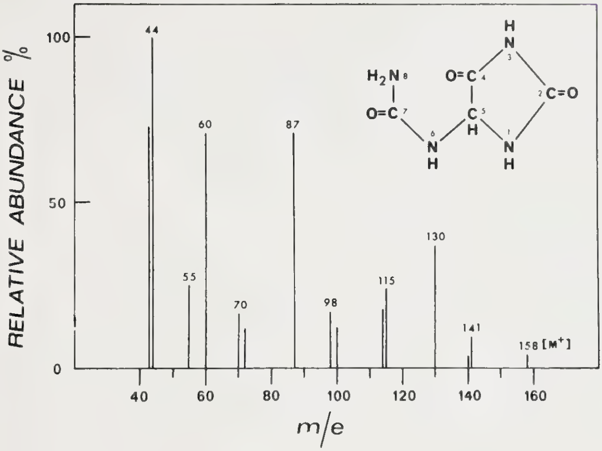

Fig. 2.
Mass spectrum of crystalline compound from *Protea compacta* seed identified as allantoin.

Elemental analysis gave the following results:

	Found	Calculated
C	30,48%	30,38%
H	3,87%	3,82%
N	35,63%	35,44%

The above analytical data yielded a molecular formula of $C_4H_6N_4O_3$. The physical data coupled with the fact that there was no depression of melting point when mixed with authentic material proves that the compound is racemic allantoin with the structure as indicated in Fig. 2.

Discussion

The identification of allantoin in seed of *Protea compacta* adds to its already long history as a plant constituent. It was first isolated in 1881 by Schulze and Barbieri from sprouting shoots of *Platanus orientalis* and has subsequently been found in 22 families of flowering plants (Tracey, 1955). The fact that it is usually present in relatively high concentrations in plants suggests that it plays an important role in nitrogen metabolism. It would appear as if it is most abundant in xylem sap, ripening fruits, seeds and young developing leaves, flowers and seedlings (Tracey, 1955). All these are either organs in which large quantities of food reserves are stored or tissues which have a rapid rate of metabolism. Very little definite information is, however, available regarding the physiological function of allantoin in plant material. Its frequent occurrence in seed led to the suggestion that it serves as a storage product for nitrogen (Mothes, 1958). It has also been postulated that it plays a role in the detoxification of ammonia, that it might be the form in which nitrogen is translocated in plants, or that it is a degradation product of purines (Mothes, 1958). The fact that it is present in *Protea compacta* seed where the major seed reserves are proteins (±65%), yet is absent in *Leucospermum reflexum*, a genus in the same family where the food reserve is lipid (±55%) (unpublished), suggests that it may act as a storage product in the former species. Since allantoin levels have been reported to increase during germination it may be that it is actively synthesized or alternatively it is formed as a result of purine degradation during this process (Barash, 1972).

The possibility of allantoin acting as an intermediate storage produce in the seed of *Protea compacta* is presently being investigated.

ACKNOWLEDGEMENTS

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STUDIES IN THE BULBOUS LILIACEAE IN SOUTH AFRICA: 5. SEED SURFACE CHARACTERS AND GENERIC GROUPINGS

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Abstract

Scanning electron microscope studies were made on the surface of the seeds of 49 specimens of 25 genera of South African Liliaceae. Five groups of genera of bulbous Liliaceae are recognised on the basis of seed surface characters.

It is suggested that three tribes should be recognised in the South African bulbous Liliaceae—the Scilleae, Massonieae and Bowieae. These are defined and the genera in each are listed.

Uittreksel

STUDIES VAN DIE BOLDRAENDE LILIACEAE IN SUID-AFRIKA: 5. KENMERKE VAN DIE SAADOPPERVLAK EN GENERIESE GROEPERINGS

Skandeer-elektronmikroskoop opnames van die saadoppervlak van 49 eksemplare van 25 genera Suid-Afrikaanse Liliaceae is gemaak. Vyf groepe genera van boldraende Liliaceae word erken op die basis van die saadoppervlakte kenmerke.

Dit word voorgestel dat drie tribusse boldraende Liliaceae in Suid-Afrika erken behoort te word—Scillae, Massonieae en Bowieae. Hierdie word defineer en die genera in elk gemeld.

Introduction

The South African bulbous Liliaceae genera have been placed in various tribes of the Liliaceae by different authors. It is generally agreed that the majority belong to a single tribe. Krause (1930) called the major group Scilloideae. *Schizobasis*, *Bowiea* and *Eriospermum* were included in a separate tribe—the Eriosperminae.

Hutchinson (1959) recognised the Scilleae and two other tribes—the Massonieae with two genera (*Massonia and Daubenya*) and the Bowieae with three genera (*Schizobasis*, *Bowiea* and *Eriospermum*).

Other authors have commented on the grouping of the bulbous genera, for example Phillips (1951) linked *Massonia* with *Polyxena*, *Neobakeria*, *Whiteheadia*, *Neopatersonia*, *Androsiphon* and *Amphisiphon* on the basis of their connate stamens, but no attempt has been made at revising tribal groupings.

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Generic concepts in the Scilleae still require attention. Jessop (1970 & 1972) has proposed a few generic changes, but there are several genera which may require redefinition—for example *Massonia* and *Drimia*. The genera at present recognised (excluding certain species belonging to the Aloineae) are:– *Schizobasis, Bowiea, Urginea, Rhadamanthus, Thuranthos, Drimia, Litanthus, Massonia, Daubenya, Androsiphon, Amphisiphon, Neobakeria, Polyxena, Hyacinthus, Veltheimia, Eucomis, Whiteheadia, Lachenalia, Ledebouria, Scilla, Drimiopsis, Neopatersonia, Galtonia, Pseudogaltonia, Ornithogalum, Elsiea, Albuca* and *Dipcadi.*

In an attempt to find a meaningful grouping of these genera, certain approaches have been tried, including the use of scanning electron microscope photographs of seed surfaces.

The assistance of Mr. R. H. M. Cross (Officer-in-charge of the Electron Microscopy Unit, Rhodes University) is gratefully acknowledged.

MATERIALS AND METHODS

The seed of 49 plants belonging to 43 species in 25 genera of Liliaceae were examined. Most of the material used was taken from herbarium specimens, but some fresh material was used. No differences in the seeds appeared to result from the use of dried material.

A thin layer of gold palladium alloy was evaporated onto the surface of the samples. The material was examined under a J.E.O.L. JSM U3 scanning electron microscope and in all cases photographs were taken.

OBSERVATIONS

The following brief descriptions are based on the photographs. Because of the limited material examined it is not considered justified to draw up more detailed descriptions.

Bulbine

B. frutescens (Ex hort., Rhodes University)

The concave, more or less isodiametric, cells with several papillae are not similar to those in any other material examined. Cells measure 160–240 μm diameter (Fig. 1A). This plant was included for comparison but is not bulbous.

Schizobasis

S. intricata (Klaasvoogds, Robertson (3319D), *Esterhuysen 22711*, BOL).

Sub-rectangular ridges probably represent cell margins, but their irregular arrangement suggests that they may be wrinkling, perhaps as a result of drying.

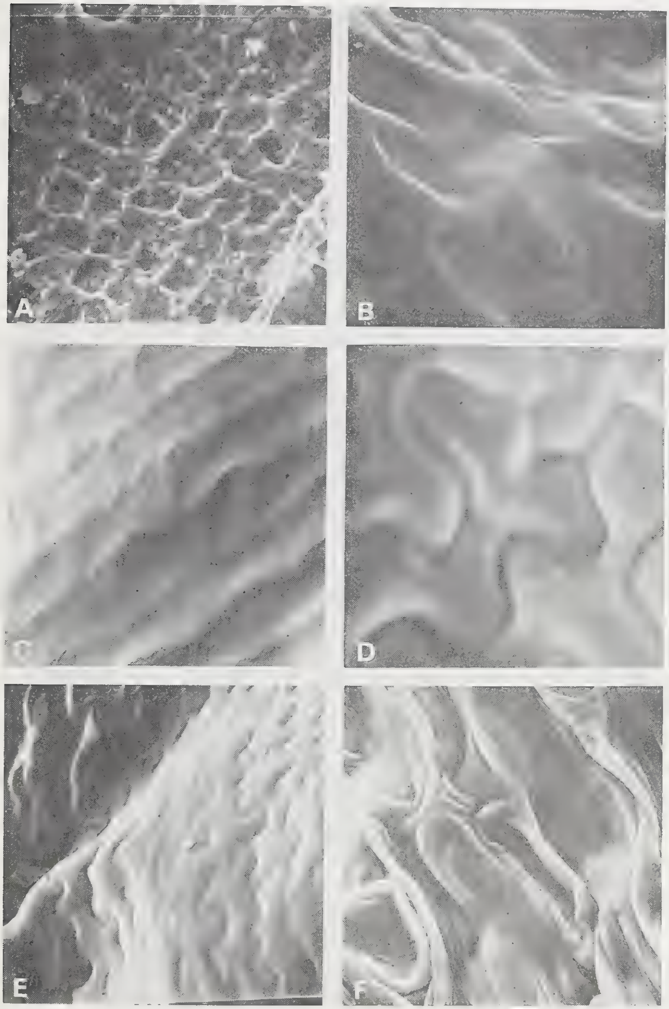

Fig. 1.
Scanning electron microscope photographs of Liliaceae seed surfaces. A. *Bulbine frutescens* (Ex hort., Rhodes University) x 300. B. *Schizobasis intricata* (*Esterhuysen* 22711) x 700. C. *Bowiea volubilis* (*Galpin s.n.*) x 200. D. *Albuca patersonii*. (*Martin s.n.*) x 700. E. *Galtonia princeps* (*Strey* 4516) x 200. F. *Drimia anomala* (*Esterhuysen* 18343) x 700.

There is some similarity with several species of *Drimia* and *Urginea*. 'Cells' concave with smooth surfaces (Fig. 1B).

Bowiea

B. volubilis (Byrne, Richmond, Natal (2930C), *Galpin s.n.*, BOL).

Rectangular convex cells with slightly undulate margins and a smooth surface are characteristic, but it is somewhat intermediate in form between *Urginea modesta* and *U. marginata*. It is also similar to *Galtonia princeps*. Cells measure 120–130×40–50 μm (Fig. 1C).

Albuca

A. canadensis (Huguenot College, Wellington, without collector, sub RUH *4473*, RUH).

Cells with smooth surface and undulate margins, 130–180×20–30 μm.

A. patersonii (Without locality, *Martin s.n.*, sub RUH *9548*, RUH).

Cells with smooth surface and more deeply undulate margins than in *A. canadensis*, c. 90–120×c. 30 μm (Fig. 1D).

These two species are very similar to one another. The cell outline is similar to that of some species of *Urginea* and/or *Ornithogalum* but in those genera there are conspicuously raised areas in the seed surface which are absent in *Albuca*. There is a strong similarity with *Neopatersonia uitenhagensis*, which has pits however, and with *Galtonia princeps*, which has more rectangularly shaped cells.

Galtonia

G. princeps (Port Edward 3130A), *Strey 4516*, PRE).

Cells with smooth surface and undulate margins, c. 120–150×c. 30 μm. The sub-rectangular cells are more deeply undulate than, but similar to, those of *Bowiea volubilis* (Fig. 1E).

Drimia

D. anomala (Uniondale, near Joubertina (3323D), *Esterhuysen 18343*, PRE).

Cells with contorted surface, minutely rough (the protuberances less than 1 μm diameter), 5- or 6-angled, 40–60×20–30 μm (Fig. 1F).

D. media (Great Drakenstein (3418B), *Esterhuysen 21348*, BOL).

Cells with more or less smooth surface, more or less rectangular, 80–200×40–50 μm (Fig. 2A).

Because of the probably very close relationship, *Drimia* is discussed at the end of the description of *Urginea*.

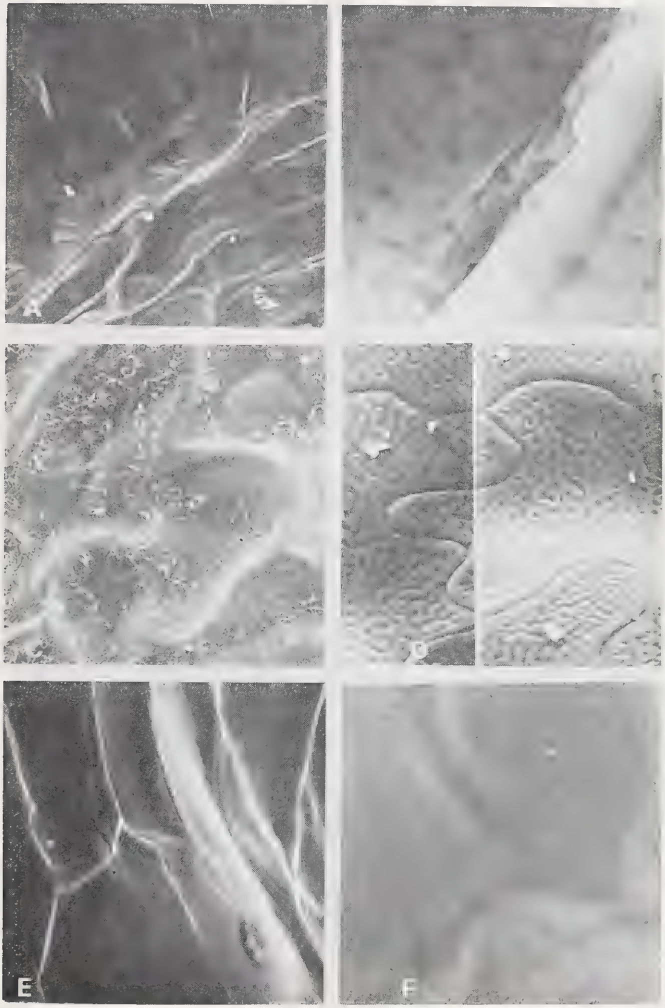

FIG. 2.
Scanning electron miscroscope photographs of Liliaceae seed surfaces. A. *Drimia media* (*Esterhuysen* 21348) x 200. *B. Urginea delagoensis* (*Buitendag* 118) x 2000. C. *Urginea basutica* (*Strey* 3128) x 200. D. *Urginea fragrans* (*Godfrey* VH-1254) x 700. E. *Urginea pusilla* (*Marloth* 857) x 700. F. *Urginea sanguinea* (*Marloth* 7686)x 700.

Urginea

U. delagoensis (Nelspruit (253OB), *Buitendag 118*, PRE).

Cells with pitted surface (the pits up to 1–1,3 μm diameter), otherwise smooth, rectangular, 300–400 × 40–60 μm (Fig. 2B).

U. basutica (Willow Glen, Pretoria (2528C), *Strey 3128*, PRE).

Cells with numerous curled threads and ribbons and pits (the pits c. 1–2 μm diameter), irregular in outline, convex, 80–230 × 70–120 μm (Fig. 2C). The threads and ribbons are removed by boiling briefly in water and are likely to consist of wax. They are, however, not soluble in Xylol at 20 °C.

U. fragrans (7 miles S. of Klaver (3118D), *Godfrey VH-1254*, PRE).

Cells with the surface covered by a dense reticulation of minute ridges (the ridges 1–1,5 μm thick), concave, the margins undulate and indicated by distinct grooves, 230–300 × 30–50 μm (Fig. 2D).

U. pusilla (Bultfontein, Kimberley (2824D), *Marloth 857*, PRE).

Cells with smooth surface, irregular in outline, 110–240 × 40–70 μm (Fig. 2E).

U. sanguinea (Without locality, *Marloth 7686*, PRE).

Cells with pitted surface (pits 1–1,5 μm diameter), with deeply undulate margin, 200–300 × 30–50 μm (Fig. 2F).

U. modesta (near Premier Mine (2528C), *Young s.n.* sub Tvl. Mus. *32493*, PRE).

Cells with almost smooth surface, rectangular, c. 65 × 20–25 μm (Fig. 3A).

U. modesta (Albany district above Rabbits Wood (3326B), *Jessop 853*, RUH).

Cells not distinguishable, with irregular surface (Fig. 3B).

U. multisetosa (Willow Park, Pretoria (2528C), *Strey 3054*, PRE).

Cells with smooth surface, with undulate margins, 100–130 × 50–60 μm.

U. multisetosa (Duiwelskloof (2330C), *Scheepers 686*, PRE).

Cells with smooth surface, with irregular margins, 150–210 × 40–100 μm (Fig. 3C).

U. marginata (Richtersveld, *Pillans 5780*, BOL).

Cells with smooth surface, with undulate margins, 120–150 × c. 50 μm (Fig. 3D).

Drimia and *Urginea* can be shown, on several bulb and inflorescence characters, to be very closely related. Discussion of the seeds of both is, therefore, treated together. There is considerable variation in cell shape, but the cells are generally clearly recognisable. In one specimen of *U. modesta* they are subrectangular, but in the other specimen of the same species they are probably constricted in the centre although the outline is poorly defined. Several specimens have rather deeply undulate margins (e.g. *U. fragrans*). In a few specimens (e.g. *U. delagoensis*) the boundaries of cells are poorly defined. In surface characters there is also considerable variation from smooth (e.g. *U. pusilla*) to pitted (e.g. *U. delagoensis*). In *U. fragrans* there is a reticulation of minute ridges.

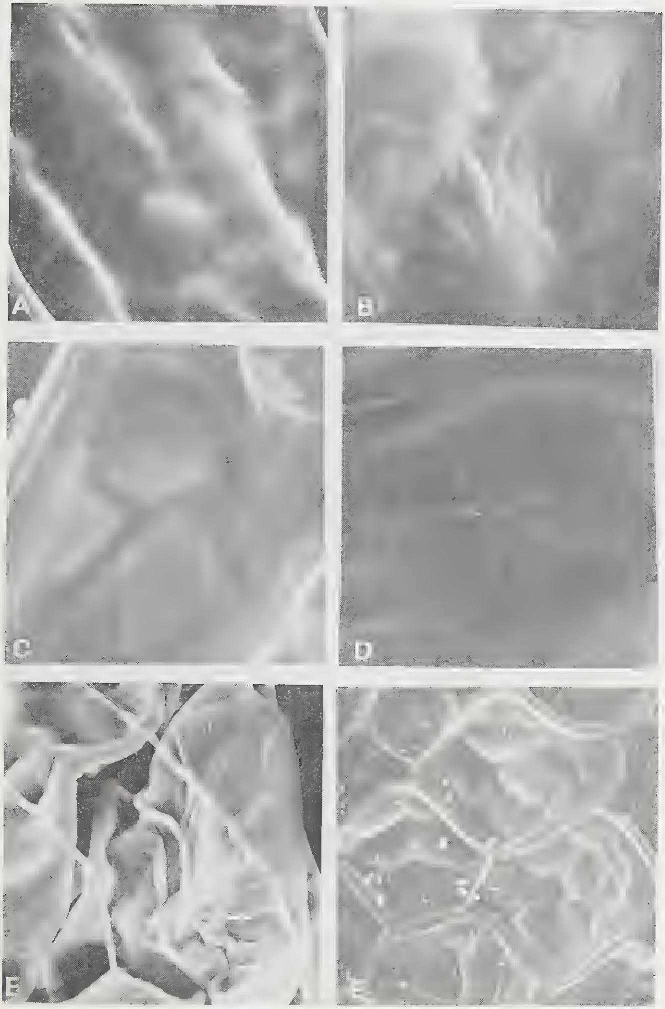

FIG. 3.
Scanning electron microscope photographs of Liliaceae seed surfaces. A. *Urginea modesta* (*Young s.n.*) x 700. B. *Urginea modesta* (*Jessop* 853) x 700. C. *Urginea multisetosa* (*Scheepers* 686) x 700. D. *Urginea marginata* (*Pillans* 5780) x 700. E. *Litanthus pusillus* (*Jacot Guillarmod* 3233) x 700. F. *Rhadamanthus platyphyllus* (*Hall* 3473) x 200.

Because of the variation it is not possible to compare these genera as a whole with other genera. There does not appear to be any correlation with the normal division of this group into two genera in the sense of, for example, Phillips (1951).

Litanthus

L. pusillus (Lesotho, Mamathes (2927B), *Jacot Guillarmod 3233*, RUH).

Cells mostly not distinguishable, with a considerably folded surface, rough with ridges up to 1 μm thick, 5- or 6-angled, c. 20–25 μm diameter (Fig. 3E).

The rather poorly defined cells are somewhat similar to those of one specimen of *Urginea modesta*, but the rugulose surface is unique amongst the samples examined.

Rhadamanthus

R. platyphyllus (Strandfontein, Vredendal (3118C), *Hall 3473*, NBG).

Cells smooth, 4- to 7-angled, isodiametric to oblong, depressed, 80–240 μm diameter. Underlying cells forming shallow convexities in the surface of the superficial cells (Fig. 3F).

R. sp. (Ex hort., Rhodes University).

Cells smooth, 5- or 6-angled, depressed, 70–150 × 50–70 μm. Underlying cells forming shallow convexities in the surface of the superficial cells.

In both specimens examined the cells are exceptionally clearly delimited by prominent marginal ridges. The underlying cells are also distinct. It is possible that the gold palladium may not have been thick enough to prevent a large number of electrons from passing through the surface of the seed. But as this phenomenon was not observed in samples of other genera it is believed to be due to a characteristic in the seed surface.

Dipcadi

D. ciliare (Bushman's River Mouth (3326D), *Noel s.n.* sub RUH *12089*, RUH).

Cells pitted with numerous shallow pits c. 1 μm diameter, 5- or 6-angled, 60–130 × 30–45 μm. Some cells appeared to be abruptly raised above the surrounding cells, but this may be an artefact (Fig. 4A).

D. viride (Burnt Kraal, near Grahamstown (3326B), *Martin s.n.* sub RUH *9271*, RUH).

Cells smooth, 5- to 7-angled, 40–50 μm diameter (Fig. 4B).

In both of the species examined the cells are 5- or 6-angled (rarely 7-angled), not often more than twice as long as broad. The most similar species examined are in the *Urginea-Drimia* group (in which the cells are not as distinctly angled, however), and in *Rhadamanthus* (in which the margins are raised and the underlying cells visible).

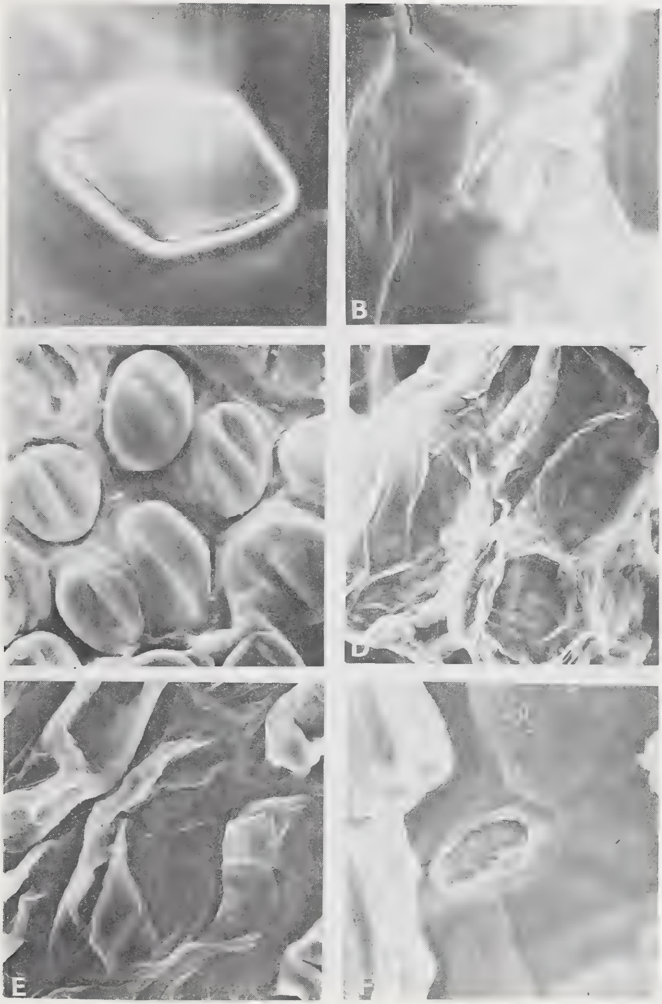

FIG. 4.

Scanning electron microscope photographs of Liliaceae seed surfaces. A. *Dipcadi ciliare* (*Noel s.n.*) x 700. B. *Dipcadi viride* (*Martin s.n.*) x 700. C. *Scilla firmifolia* (Ex hort., Rhodes University) x 700. D. *Scilla nervosa* (*Leendertz s.n.*) x 700. E. *Scilla natalensis* (*Mogg* 2238) x 700. F. *Ledebouria floribunda* (*Van der Merwe* 2240) x 700.

Scilla

S. firmifolia (Ex hort., Rhodes University).

Cells distinctly papillose (the papillae rather flattened with three grooves), 5– or 6–angled, 25–35 μm diameter (Fig. 4C).

S. nervosa (Warmbaths (2428C), *Leendertz s.n.* sub Tvl. Mus. 28064, PRE).

Cells indistinct, probably 5– or 6–angled, 30–40 μm diameter; structures resembling thin-walled papillae present (Fig. 4D).

S. natalensis (Pietermaritzburg (2930C), *Mogg 2238*, PRE).

Cells indistinct, probably 5– or 6–angled, 30–40 μm diameter; structures resembling thin-walled papillae present (Fig. 4E).

Three of the four species of *Scilla* recognised by Jessop (1970) were examined. In both *S. nervosa* and *S. natalensis* there is a wrinkling of the surface which may be caused by the collapse of the convex outer walls. In *S. firmifolia*, however, there are large papillae each with 1–3 (usually 3) furrows. If the appearance of the former two species is caused by the collapse of thin-walled papillae, the differences between them and *S. firmifolia* may not be as great as the first impression of the photographs may suggest. Although the cells of *S. nervosa* and *S. natalensis* are indistinct it is thought likely that all species have 5– or 6–angled cells. These observations give support to the retention of *S. nervosa* in *Scilla* rather than in *Schizocarphus* as proposed by Van der Merwe (1943).

Ledebouria

L. floribunda (Happy Rest, Soutpansberg, N. Tvl., *Van der Merwe 2240*, PRE).

Surface very irregular; the outermost layer (wax-like in appearance) apparently damaged. Cells arranged in regular rows, more or less 4-angled, 15–25 μm diameter (Fig. 4F).

It is not certain that the cell-like patterns are in fact cells as the larger cell-like shapes are subdivided by shallower grooves. There is a close similarity with the *Massonia* group and possibly with *Lachenalia*. The round structure in the photograph is thought to be a result of damage.

Eucomis

E. autumnalis var. *clavata* (Tabamhlope, Estcourt (2929B), *Downing 53A*, PRE).

Shallow depressions over whole surface c. 20–40 μm diameter. Minute, more or less reticulate, ridges c. 0,1 μm wide over both raised and depressed portions, otherwise smooth (Fig. 5A).

The surface shows no evidence of cells and is similar to some members of the *Massonia* group.

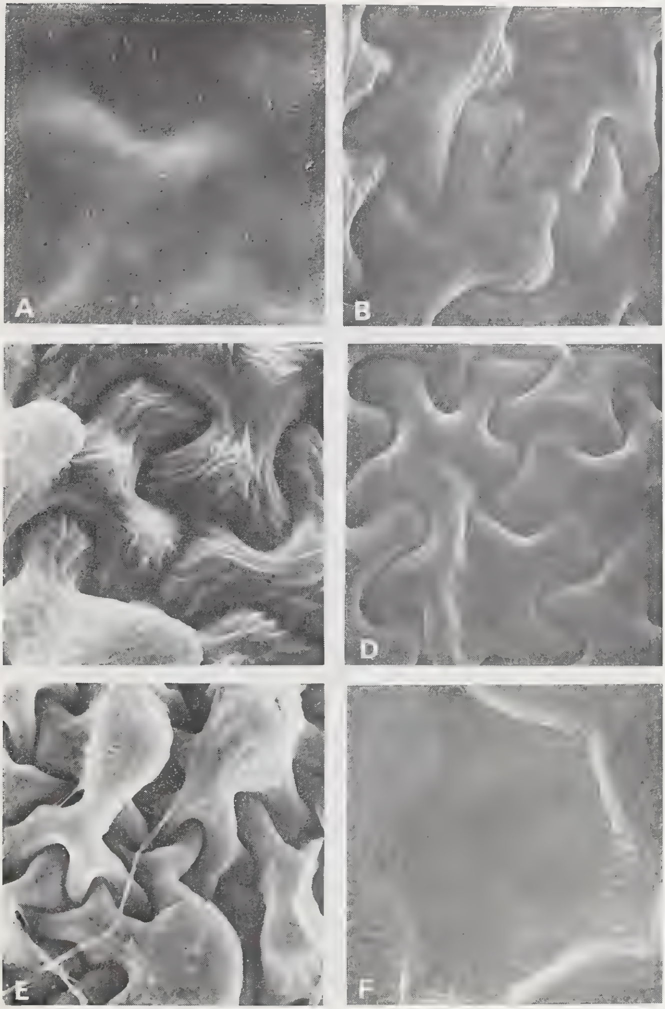

FIG. 5.

Scanning electron microscope photographs of Liliaceae seed surfaces. A. *Eucomis autumnalis* var. *clavata* (*Downing* 53A) x 700. B. *Ornithogalum thyrsoides* (Bought at Houtbay Neck) x 700. C. *Ornithogalum conicum* (*Leipoldt* 4374) x 700. D. *Ornithogalum ceresianum* (*Goatcher s.n.*) x 700. E. *Ornithogalum miniatum* (*Muir* 2988) x 700. F. *Pseudogaltonia clavata* (*Tölken s.n.*) x 700.

Ornithogalum

O. thyrsoides (Table Mountain above Kirstenbosch (3418A), *Bolus 4919*, PRE).

Cells with smooth surface but separated from one another by deep grooves, with undulate margins, 110–150 × c. 50 μm.

O. thyrsoides (Bought at Houtbay Nek, PRE).

Cells with smooth surface but separated from one another by deep grooves, with undulate margins, 110–150 × c. 40 μm (Fig. 5B).

O. conicum (Clanwilliam (3218B), *Leipoldt 4374*, PRE).

Cells papillose (the papillae verrucose), with undulate margins, 90–140 × 30–40 μm (Fig. 5C).

O. ceresianum (Ceres (3319A), *Goatcher s.n.* sub BOL *13726*, PRE).

Cells with smooth surface, with undulate margins, 90–130 × 40 μm (Fig. 5D).

O. maculatum (Sandberg near Clanwilliam (3218B), *Leighton s.n.* sub BOL *2161*, PRE).

Cells with minutely verrucose surface, deeply grooved between the cells, with undulate margins, 65 × 20 μm.

O. miniatum (Near Riversdale (3421A), *Muir 2988*, PRE).

Cells with numerous shallow depressions c. 1,0 μm diameter, with undulate margins, c. 70 × 20 μm. Each cell produced into a papilla up to 70 μm long (Fig. 5E).

O. miniatum (Kommaggas (2917D), without collector sub Stellenbosch University Garden no. *3983*, PRE).

Cells with numerous shallow depressions c. 1,0 μm diameter, with undulate margins, 70–80 × c. 20 μm. Each cell produced into a papilla up to 80 μm long.

The seven specimens examined were all very similar, with deep grooves between the cells and the outer tangential walls strongly convex or produced into papillae. There is a similarity with *Galtonia princeps* and, to a limited extent, with *Albuca* and the *Urginea-Drimia* group, but these genera have flatter cells.

Pseudogaltonia

P. clavata (Sturmveld, Gobabis (2119), *Tölken s.n.*).

Cells with surface reticulately patterned with shallow depressions c. 20 μm diameter, sub-isodiametric, 5- to 7-angled, 65–100 μm diameter (Fig. 5F).

The cell pattern is similar to that in *Scilla* and *Dipcadi*, but the surface reticulation is more similar to that of a few species of the *Urginea-Drimia* group.

Lachenalia

L. monophylla (Storms River (3323D), *Seagrief s.n.* sub RUH *22228*, RUH).

Surface wrinkled, with a pattern of subrectangular cells c. 30–40 × 30 μm (Fig. 6A).

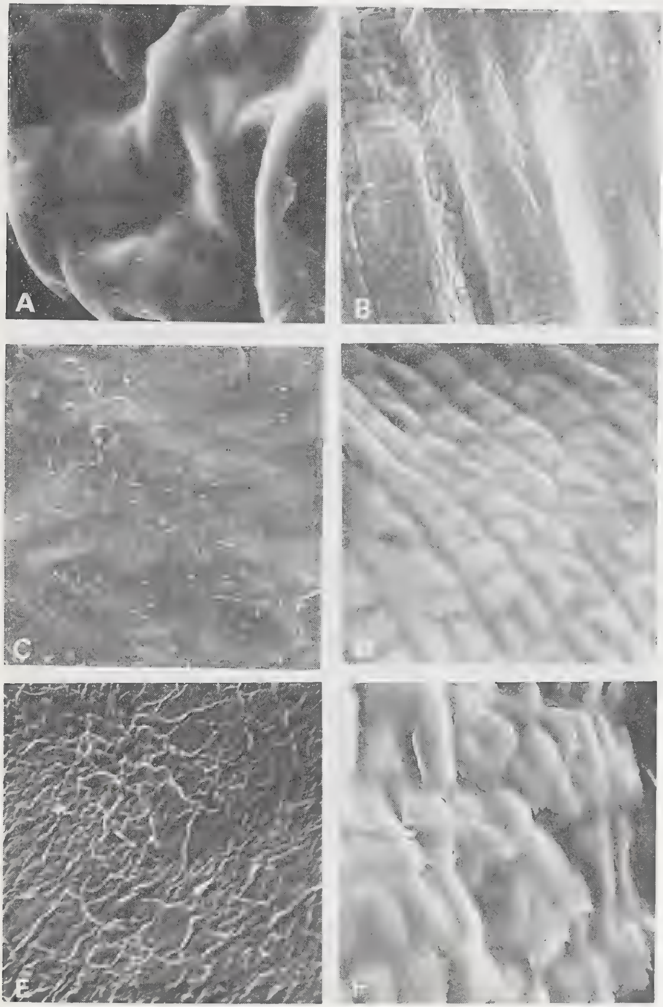

FIG. 6.
Scanning electron microscope photographs of Liliaceae seed surfaces. A. *Lachenalia monophylla* (*Seagrief s.n.*) x 700. B. *Whiteheadia bifolia* (*Hardy* 542) x 200. C. *Neobakeria angustifolia* (*Friedlander s.n.*) x 700. D. *Massonia depressa* (*Marloth* 10367) x 700. E. *Massonia echinata* (*Bayliss BS*/4868) x 3000. F. *Massonia putulata* (*Acocks* 21339) × 700.

The absence of surface details allies this specimen with the *Massonia* group.

Whiteheadia

W. bifolia (Ratelpoort between Springbok and Steinkopf (2917D), *Hardy 542*, PRE).

Surface wrinkled, with rows of more or less 4-angled cells 10–23 μm diameter (Fig. 6B).

Examination of freezing microtome sections confirmed that the cell-like convexities agree in size with the epidermal cells and are, therefore likely to indicate the cell walls.

Neobakeria

N. angustifolia (De Aar (3024C), *Friedlander s.n.*, GRA).

Surface smooth except for cells which are 5- or 6-angled and 20–30 × c. 10 μm. This seed belongs to the *Massonia* group (Fig. 6C).

Massonia

M. depressa (Without locality, *Marloth 10367*, PRE).

Surface smooth except for cells arranged in rows and 7–10 μm diameter (Fig. 6D). Freezing microtome sections confirmed that these patterns do represent cells.

M. echinata (Near Klipplaats Village (3324A), *Bayliss BS/4890*).

Surface coarsely verrucose with ridges down to less than 1 μm diameter. Cells not distinguishable.

M. echinata (Near the Redhouse turnoff (3325D), *Bayliss BS/4868*).

Surface coarsely verrucose with papillae and ridges down to less than 1 μm diameter. Cells not distinguishable (Fig. 6E).

M. pustulata (Locality not recorded, *Acocks 21339*, PRE).

Surface smooth except for more or less square cells c. 10–15 μm diameter (Fig. 6F).

Epidermal cells are either not recognisable or (as in *Whiteheadia*) there are rectangular or triangular cells.

Daubenya

D. aurea (Sutherland (3220A), *Marloth 7106*, PRE).

Surface smooth except for cells which are 4- to 6-angled and 18–23 μm diameter (Fig. 7A).

The cell pattern is similar to that in *Whiteheadia* and in some species of *Massonia*.

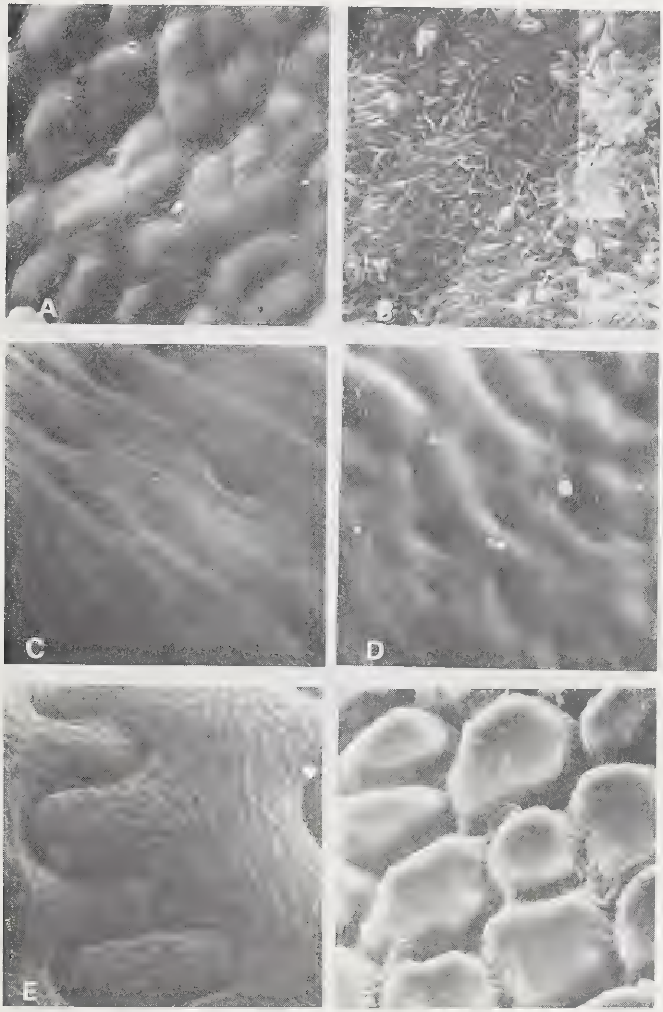

FIG. 7.
Scanning electron microscope photographs of Liliaceae seed surfaces. A. *Daubenya aurea* (*Marloth* 7106) x 700. B. *Androsiphon capense* (*Acocks* 18606) x 700. C. *Polyxena ensifolia* (*Dyer* 99a) x 700. D. *Hyacinthus corymbosus* (NBG 374/64) x 700. E. *Neopatersonia uitenhagensis* (*Long* 135) x 700. F. *Asparagus virgatus* (Ex hort., Rhodes University) x 700.

Androsiphon

A. capense (Farm Plaatberg, S.W. of Calvinia (3119B), *Acocks 18606*, PRE).

Cells 4- to 6-angled, 13–23 μm diameter. Surface naked or densely lepidote; the scales irregular in form and arrangement and up to c.3 μm broad (Fig. 7B).

At low magnifications (×100) the surface appears indistinguishable from other members of the *Massonia* group. However, higher magnifications showed a unique scaly covering of one of the four specimens examined.

Polyxena

P. ensifolia (Oudtshoorn (3322C), *Dyer 99a*, GRA).

Cells not distinguishable. Surface more or less smooth with shallow pits up to c.10 μm diameter (Fig. 7C). There is a close similarity with *Neobakeria angustifolia* and *Hyacinthus corymbosus*.

Hyacinthus

H. corymbosus (Witklip Farm, Vredenburg, without collector sub NBG *374/64*, NBG).

Cells not distinguishable. Surface more or less smooth with shallow pits up to c.10 μm diameter (Fig. 7D).

There is a close similarity with *Neobakeria angustifolia* and *Polyxena ensifolia*.

Neopatersonia

N. uitenhagensis (Bethelsdorp (3325D), *Long 135*, GRA).

Cells pitted (the pits c. 1–1,5 μm diameter), with undulate margins, c. 130–170×60–70 μm (Fig. 7E).

The shape of the cells is similar to that of *Albuca* and to some specimens of the *Urginea-Drimia* group. The pits are reminiscent of the *Urginea-Drimia* group or of *Pseudogaltonia*.

Asparagus

A. virgatus (Ex hort., Rhodes University).

Cells smooth, slightly concave, separated from one another by grooves with almost vertical sides, c. 5–6 μm deep, isodiametric, 5- or 6-angled, 30–40 μm diameter. The raised tubular cells are unlike any others in the material examined (Fig. 7F). *Asparagus* was included for comparison but is not bulbous.

SEED-SURFACE TYPES

Several essentially different types of seed surfaces were observed in the bulbous Liliaceae.

1. The *Massonia* group (*Whiteheadia*, *Lachenalia*, *Ledebouria*, *Massonia*, *Neobakeria*, *Eucomis*, *Daubenya*, *Androsiphon*, *Polyxena* and *Hyacinthus*) possess either no indication of cells or rectangular or triangular shapes (generally about 15 μm diameter) cells.
2. The *Ornithogalum* type (*Ornithogalum*) possesses deeply separated cells with strongly undulate margins.
3. Cells with deeply undulate margins, but flatter outer tangential walls than in *Ornithogalum* (*Albuca*, *Galtonia* and *Neopatersonia*).
4. Angular cells (*Scilla*, *Dipcadi*, *Rhadamanthus* and *Pseudogaltonia*).
5. *Drimia*, *Urginea*, *Litanthus*, *Schizobasis* and *Bowiea* do not fit exactly into any of the above types although certain species of the *Urginea-Drimia* group could be allocated to types 3 or 4. Other species have less deeply undulate outlines than in the previous types or more or less rectangular cells.

GENERIC GROUPINGS

The Bowieae (*sensu* Hutchinson) deviate further from the norm of bulbous Liliaceae than do any of the other previously proposed groups. Within this tribe there are, however, two very different elements. *Bowiea* and *Schizobasis* have bulbs, no foliage leaves in the mature plant and spurred bracts. *Eriospermum* has a tuber, foliage leaves (usually hysteranthous) and bracts without spurs. *Eriospermum*, in the absence of a bulb, is not discussed further here.

The affinities of *Bowiea* and *Schizobasis* are of interest. They differ from any other South African members of the bulbous Liliaceae in lacking foliage leaves in the mature plant (although they are present in juvenile stages), and in having a branched aerial stem (present also in *Scilla firmifolia*). These two genera resemble several other genera in, what are considered by the present author to be, a number of important characters. These characters are the spurred bracts, absence of starch from the bulb, and loose testa. The genera to which these characters ally them are *Drimia*, *Urginea*, *Rhadamanthus*, *Thuranthos* and *Litanthus*. The flowers and bulbs are similar and the present work on seed surface characters tends to support this conclusion. A basic chromosome number of 10 is probably also a common feature, although further data are required.

Two evolutionary processes must be postulated to explain the relationship between these two groups:

(*a*) reduction in the size of the foliage leaves which are present in the seedlings of *Bowiea* and *Schizobasis* and at all stages of the other genera, but in the former two genera are reduced, to bulb scales only, in the mature plant;
(*b*) development of branches in the inflorescence.

It is suggested that these evolutionary developments, while of undoubted systematic importance, do not justify subdivision of the proposed group including *Bowiea*, *Schizobasis*, *Urginea*, *Drimia*, *Rhadamanthus*, *Thuranthos* and *Litanthus*. So far as is known there are no genera belonging to this group not represented in the South African flora. A revision of *Rhadamanthus* has recently been published (Nordenstam, 1970) and a revision of the remaining genera will be published shortly by the present author.

The only other tribe split off the Scilleae has been the Massonieae (Hutchinson, 1959). Seed surface characters, as shown in this paper, appear to link several genera, including the two placed in the Massonieae (*Massonia* and *Daubenya*). These genera (*Massonia*, *Daubenya*, *Whiteheadia*, *Lachenalia*, *Ledebouria*, *Neobakeria*. *Eucomis*, *Androsiphon*, *Polyxena* and *Hyacinthus*), and *Amphisiphon* and *Drimiopsis* which were not studied, have morphologically similar bulbs, leaves and inflorescences. Most have representatives with leaves marked with various shades of green or red-purple. *Neopatersonia* was regarded by Phillip (1951) as also belonging to this group but seed surface characters appear to provide strong evidence for separating it. Although there are no strong characters for uniting the members of this group, except for the seed surface characters, there are several features uniting various combinations of genera within the group. These are:—

(*a*) *Lachenalia*, *Ledebouria* and *Drimiopsis* appear to have axillary inflorescences (Jessop, 1972). The rest of the genera have not been determined.

(*b*) *Lachenalia pusilla*, which has very slightly zygomorphic flowers, links *Lachenalia* (zygomorphic) with *Polyxena* (actinomorphic). Both genera and *Hyacinthus* (Cape species only) have a tubular membranous bulb scale as well as fleshy scales.

(*c*) The *Eucomis* flower is similar to that of *Massonia*, and *Whiteheadia* forms an intermediate between these genera. The coma occurs in one species of *Neobakeria* as well as in *Eucomis*, although it is not as well developed in the *Neobakeria*. A coma does also occur in a few genera not included in this group—for example in *Muscari* (European and Asian).

(*d*) *Drimiopsis* and *Ledebouria* are separated only on the incurving, subcucullate perianth of the former. In all other respects these two genera are extremely close.

(*e*) *Massonia* forms a natural group with certain other genera as has been pointed out by Phillips (1951). The members of this group are separated from one another on a fairly small number of characters—for example *Daubenya* from *Massonia* on the zygomorphic flower, *Neobakeria* from *Massonia* on the absence of large spathe-like bracts, *Polyxena* from *Neobakeria* on the insertion of the filaments and the membranous bulb scales.

The remaining genera, not placed in the *Urginea-Drimia* group or the *Massonia* group, from a heterogeneous assemblage, with little to link the genera. *Scilla*, *Ornithogalum* and *Dipcadi* occur in South Africa and in Europe and Asia.

Galtonia, *Pseudogaltonia*, *Albuca* and *Neopatersonia* are principally South African but endemic to Africa. *Camassia* occurs in North America only, *Chionodoxa*, *Hyacinthus* (excluding the Cape species belonging to the *Massonia* group), *Muscari* and *Puschkinia* are northern hemisphere in distribution, mainly from Europe and Asia but also North Africa. *Rhodocodon* is endemic to Madagascar. Because of the wide distribution of this group the material has not been available to the present author to examine fully the affinities of these genera.

The following grouping of those genera (other than members of the Aloineae), which have bulbs and which occur in South Africa (or are closely allied to South African genera) is proposed:—

1. Tribe Scilleae *sensu* Hutchinson (1959), emend.
   Bulb containing starch, leaves not spotted or marked, bracts not spurred, seeds with tightly fitting testa and a distinct cellular pattern superficially.
   Scilla, *Ornithogalum*, *Dipcadi*, *Galtonia*, *Pseudogaltonia*, *Albuca*, *Camassia*, *Chionodoxa*, *Rhodocodon*, *Hyacinthus* (northern hemisphere spp), *Muscari*, *Puschkinia* and *Neopatersonia*.
2. Tribe Massonieae *sensu* Hutchinson (1959), emend.
   Bulb containing starch, leaves usually spotted or marked, bracts not spurred seeds with tightly fitting testa and indistinct or no cellular pattern superficially.
   Massonia, *Neobakeria*, *Polyxena*, *Hyacinthus* (Cape spp), *Daubenya*, *Androsiphon*, *Amphisiphon*. *Ledebouria*, *Drimiopsis*, *Lachenalia*, *Veltheimia*, *Eucomis*.
3. Tribe Bowieae *sensu* Hutchinson (1959), emend.
   Bulb not containing starch, leaves not spotted or marked, bracts spurred (or at least the lower), seeds with loosely fitting testa and a distinct cellular pattern superficially.
   Urginea, *Drimia*, *Rhadamanthus*, *Litanthus*, *Thuranthos*, *Schizobasis* and *Bowiea*.

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Jl S. Afr. Bot. 41 (2): 87–90 (1975)

DIE KARIOTIPE VAN *OROTHAMNUS ZEYHERI* (PROTEACEAE)

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UITTREKSEL

Wortelpunte van twee kiemplante van *Orothamnus zeyheri* Pappe is sitologies ondersoek en die chromosoomgetal vasgestel op 2n = 24.

ABSTRACT

THE CARYOTYPE OF *OROTHAMNUS ZEYHERI* (PROTEACEAE)
Chromosome counts from smears of root tips of two seedlings of *Orothamnus zeyheri* Pappe yielded 2n = 24 chromosomes.

INLEIDING

De Vos (1943) het die chromosoomgetalle van agt genera van die Suid-Afrikaanse Proteaceae vasgestel.

Venkata Rao (1971) tabelleer die gegewens van De Vos (1943), Lancaster (1952), Ramsay (1963), Johnson en Briggs (1963), Venkata Rao (1957) en Hair en Beuzenberg (1959).

Vir 'n plant soos *Orothamnus* wat met uitsterwing bedreig word, is dit belangrik om die chromosoomgetal te bepaal ten einde die naaste verwante te vind vir moontlike onderstokke vir ent- en okulasie-doeleindes.

Gedurende Julie 1974 is 'n poging aangewend om die haploïede chromosoomgetal te bepaal van verdelende generatiewe kerne in die stuifmeelbuise van *Orothamnus*-stuifmeel vanaf die Eddie Rubenstein Orothamnus Reservaat by Hermanus, Kaapprovinsie, Republiek van Suid-Afrika. Chromosome is wel waargeneem, maar nie duidelik en genoegsaam uitgesprei om uitsluitsel te kan gee nie. 'n Telling van dieselfde tydelik gemonteerde preparaat het 'n haploïede chromosoomgetal gelewer van n = 10 (P. van der Merwe) en n = 12 (D. van der Merwe).

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* Preliminêre resultate vir die Ph.D.-graad aan die Universiteit van Stellenbosch, onder promotorskap van Prof. Miriam P. de Vos.

Vir publikasie aanvaar 28 Februarie 1975.

MATERIAAL EN METODES

Orothamnus-vrugte wat versamel was op 30/11/73 in die Eddie Rubenstein-Reservaat is op 31/12/73 gesaai by die Assegaaiboschkwekery, Jonkershoek, Stellenbosch en het ontkiem gedurende Augustus 1974. Een van hierdie kiemplante het verrot en omgeval nog voordat die epikotiel begin verleng het. Die kiemwortel en die voet van die hipokotiel was totaal deur die infeksie vernietig. Die verrotte deel is op 15/10/74 met water weggewas en die gesonde deel van die hipokotiel met 0,1% 4(3-indoliel)bottersuur behandel en in 'n nie-steriele grondmengsel geplant. Op 28 November 1974 om 11.0 v.m. is hierdie kiemplant, waarvan die epikotiel intussen verleng het, uitgehaal en is gevind dat wortelvorming aan die basis van die hipokotiel en vanuit die stele-gebied, plaasgevind het. Die wortels is in lopende water gewas en die wortelpunte afgesny en in 'n oplossing van 0,001M 8-hidroksikinolien in water geplaas vir 3 uur en genommer 247 (P.v.d.M.). Hierna is die materiaal gefikseer in Asynalkohol (3 Etielalkohol: 1 Ysasyn) en gekleur in 45% Asynkarmyn vir 24 uur waarna platgeperste mikroskooppreparate gemaak is. 'n Tweede sterk kiemplant (5 cm) is ook ontwortel en die wortelpunte soortgelyk behandel en genommer 248. Die twee kiemplante is met 0,2% bottersuur behandel en weer geplant en onderskeidelik genommer 247 en 248 vir verwysingseksemplare.

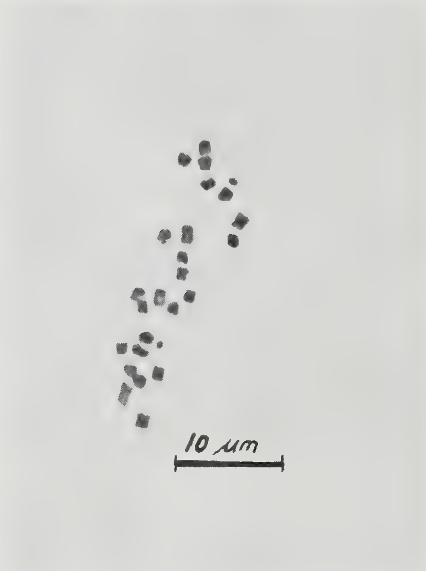

FIG. 1

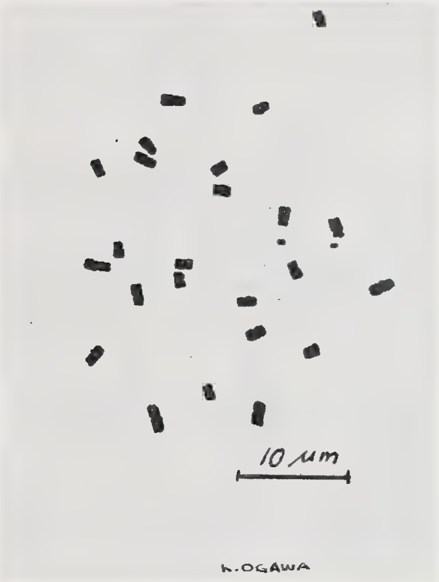

FIG. 2

RESULTATE

Die tydelike platgeperste preparate in 45% asynsuur toon 2n = 24.

Die chromosome toon effense verskille in lengte en is ongeveer 2 µm lank in hul effens verkorte toestand, te wyte aan die voorbehandeling met 8-hidroksikinolien. Hulle sentromere is mediaan of sub-mediaan en twee van die chromosome het elk 'n klein sateliet (0,5 µm lank). Hulle vertoon heelwat korter as die wat Horn (1962) vir *Protea latifolia* aantoon. Die kortste van *P. latifolia* se chromosome word aangedui as 2,2 µm terwyl dit ongeveer die lengte van die langste van *Orothamnus* se chromosome is. Hierdie resultate is egter nie absoluut vergelykbaar nie aangesien Horn as voorbehandeling 'n versadigde oplossing van monobromonaphtaleen gebruik het waarvan die krimpingseffek nie noodwendig dieselfde is as 8-hidroksikinolien nie. Die stadium wat Horn ondersoek het, was 'n laat profase, terwyl hierdie 'n metafase-stadium was.

GEVOLGTREKKINGS

Die telling n = 12 deur D. van der Merwe word bevestig deur K. Ogawa se telling van 2n = 24. Hierdie telling van 2n = 24 vir *Orothamnus* is in ooreenstemming met die resultate van De Vos (1943) wat n = 12 by vyf van die twaalf genera van die tribus *Proteeae* gevind het, naamlik *Protea*, *Leucospermum*, *Mimetes*, *Paranomus* en *Serruria*. Slegs die tweehuisige *Leucadendron* was n = 13 (wat ooreenstem met die vier Australiese genera van hierdie tribus). Sover bekend, kom n = 12 nie by die Australiese genera van die Proteaceae voor nie.

Die ander genera van die Suid-Afrikaanse Proteaceae wat Venkata Rao (1971) in aparte tribusse plaas, naamlik *Aulax* (tribus *Aulaxeae*) en *Brabeium* (tribus *Macadamieae*) se chromosoomgetalle is onderskedelik n = 11 en n = 14 (De Vos, 1943).

Vegetatiewe verenigbaarheid tussen *Orothamnus* en *Leucospermum*, *Protea*, *Mimetes*, *Paranomus* en *Serruria* (almal n = 12, de Vos, 1943) behoort dus uitgetoets te word.

DANKBETUIGING

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Jl S. Afr. Bot. 41 (2): 91 (1975)

'n NUWE NAAM VIR *DUTHIELLA*

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Dit het onder my aandag gekom dat die naam *Duthiella* De Vos vir 'n nuwe monotipiese genus van die Iridaceae 'n latere homoniem is van die reeds gepubliseerde geldige genusnaam, *Duthiella* C. Muell. ex Broth., in Nat. Pfl. 1: 1009 (1908), vir 'n blaarmosgenus behorende tot die familie Trachypodaceae. Die naam *Duthiella* vir die genus van die Iridaceae is daarom illegitiem en moet verwerp word.

Die ongelukkige fout, wat die reeds ingewikkelde plantkundige nomenklatuur nog meer ingewikkeld maak, laat hierdie genus sonder geldige naam. 'n Nuwe naam moet daarvoor gepubliseer word, gebaseer op dieselfde tipe as dié van die verwerpte naam. My keuse is:

Duthiastrum De Vos, nom. nov.

Sinoniem: Duthiella De Vos, nom. illeg., in Jl S. Afr. Bot. **40:** 301 (1974): non Broth. 1908.

Die naam van die tipe word dan *Duthiastrum linifolium* (Phill.) De Vos vir *Duthiella linifolia* (Phill.) De Vos (*Syringodea linifolia* Phill. in Ann. S. Afr. Mus. **9:** 125 (1913).

Net soos die latere homoniem *Duthiella*, is die nuwe naam ter ere van dr. A. V. Duthie (1881–1963), die eerste dosent in Botanie aan die Victoria-Kollege, later die Universiteit van Stellenbosch, en ook weens die stervormig spreidende blomdeklobbe van die plant.

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NEW TAXA AND NEW COMBINATIONS IN THE GENUS *CRASSULA*

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Abstract

84 new taxa and new combinations are proposed. Keys are provided to some species complexes.

Uittreksel

NUWE TAKSA EN KOMBINASIES IN DIE GENUS *CRASSULA*

84 nuwe taksa en nuwe kombinasies word voorgestel. Sleutels vir enige spesies komplekse is ingesluit.

The need for accepted names in several publications has prompted the author to validate new combinations and to describe new taxa before the complete taxonomic revision of the genus *Crassula* in Southern Africa appears in print. Author abbreviations as recommended for the *Flora of Southern Africa* are adopted, so that 'Schonl.' is used here for Schönland.

1. **Crassula alba** Forsk. var. **parvisepala** (Schonl.) Toelken, comb. nov.
C. rubicunda var. *parvisepala* Schonl. in Trans. Roy. Soc. S. Afr. **17:** 231 (1929). Type: Transvaal, Lydenburg, *Wilms 538* (GRA, lecto!; BM!; E!; G!; P!; Z!).

Although the flowers of this species are usually red in South Africa they do not differ morphologically from those of *C. alba* from northern Africa. *Wilms 538* is chosen as lectotype from the three syntypes, as it is well represented in many herbaria.

2. **Crassula alpestris** Thunb. subsp. **massonii** (Britt. & Bak. f.) Toelken, comb. nov. et stat. nov.
C. massonii Britt. & Bak. f. in J. Bot., Lond. **35:** 485 (1897). Type: Promontorium Bonae Spei, *Masson s.n.* (BM, holo!; PRE, photo!).

This subspecies, which occurs in two widely separated localities, seems to hybridize with the typical subspecies wherever the two taxa occur in proximity to one another. The subsp. *alpestris* usually has a terminal thyrsoid inflorescence while the subsp. *massonii* has terminal and lateral cymules.

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Accepted for publication 12th March, 1975.

3. **Crassula ammophila** Toelken, sp. nov. ab *C. subaphylla* pilis adpressis foliorum usque ad 1 mm longis et marginibus apicum petalorum non recurvis differt.
Frutices perennes caulibus fragilibus erectis usque ad 80 cm longis et juvenibus rare latioribus 0,2 cm in diametro, paucis ramosis, foliis veteribus caducis. *Folia* oblongo-lanceolates, 0,8–1,5 cm longa, 0,3–0,4 cm lata, obtusa vel acuta, plana vel leviter convexa supra, covexissima subtus, dense tecta pilis recurvis adpressis, cano-viridia vel cano-fusca; vaginae foliorum usque ad 1 mm longae. *Hydathodi* dispersi supra et subtus, inconspicui. *Inflorescentia* thyrsus terminalis oblongatus vel globosus, 1–3 dichasiis caulibus plus minusve longis, floribus sessilibus pentameris, pedunculo 1–3 cm longo et pilis recurvis adpressis, bracteis triangularibus in dichasiis. *Sepala* triangularia, 2–2,5 mm longa, obtusa vel acuta, dense tecta pilis expansis et ciliis marginalibus saepe indistinctis, succulenta cano-viridia. *Petala* panduriformia, 3–3,5 mm longa, apicibus acuminatis canaliculatis et cristis dorsalibus ad apices, 0,3–0,6 mm connata, apicibus laborum vix recurvis, eburnea. *Stamina* c. 2 mm longa, antheris nigris 0,7–0,9 mm longis, filamentis leviter latescentibus ad bases et aliquantum constrictis ubicumque connatis tubo petalorum. *Squamae* oblongae, 0,7–0,8 × 0,2–0,4 mm, leviter emarginatae, vix constrictae ad basim, parum succulentae, luteae. *Carpella* ovariis reniformibus constrictibus ad stigmates laterales rubra; ovarium 10–16 ovulis elongatis et papillis inconspicuis serialibus.

Type: Cape, Nuwerus, *Pearson 5501* (GRA, holo!; K!).

Perennials with brittle erect branches up to 80 cm long, often scrambling or rarely decumbent shrublets and with young branches rarely more than 0,2 cm in diameter and with peeling bark towards the base, little branched and with old leaves deciduous. *Leaves* sessile, oblong-lanceolate, 0,8–1,5 cm long, 0,3–0,4 cm broad, with bluntly acute or rounded apices, flat or slightly convex above and very much convex below and almost as thick as broad, densely covered with recurved adpressed hairs, grey-green to greyish-brown; sheath up to 0,1 cm long and formed by the partial fusion of the leaf bases. *Hydathodes* scattered mainly over the upper but also on the lower surface, indistinct. *Inflorescence* a terminal elongated to rounded or globular thyrse with one to three dichasia more or less stalked, with sessile 5-merous flowers, with a peduncle hardly distinct from a vegetative branch and 1–3 cm long and with adpressed hairs, with triangular bracts with rounded apex rather like the sepals. *Sepals* triangular 2–2,5 mm long, bluntly acute covered with long erect hairs and with often indistinct marginal cilia, fleshy, green. *Petals* panduriform, 3–3,5 mm long, with acuminate canaliculate apices without dorsal ridges, fused into a tube 0,3–0,6 mm long, with apices of the lobes hardly recurved, cream. *Stamens* c. 2 mm long, with black anthers 0,7–0,9 mm long, with filaments slightly

broadened towards the base and somewhat constricted where fused to the petal tube. *Squamae* oblong 0,7–0,8 × 0,2–0,4 mm, slightly emarginate, hardly constricted towards the base, fleshy, yellow. *Carpels* with reniform ovaries gradually constricted towards the sessile and somewhat laterally placed red stigmas; ovary slightly papillose and with 10–16 elongate ovules covered with rows of inconspicuous papillae.

A scrambler among shrubs of the coastal sandveld vegetation from near Saldanha Bay to north of the Holgat River.

CAPE—2816 (Oranjemund): Holgat River (-DD), *Tölken 5270* (PRE).
—3017 (Hondeklipbaai): 18 km east of Hondeklipbaai (-AD), *Wisura 891* (NBG).
—3118 (Vanrhynsdorp): Nuwerus (-AB), *Pearson 5501* (BOL, K): near Koekenaap (-AD), *Tölken 5163* (PRE).
—3317 (Saldanha): Danger Point (-BB), *Hall* in NBG *126/53* (BOL, NBG).

4. **Crassula arborescens** (Mill.) Willd. subsp. **undulatifolia** Toelken, subsp. nov. ab subsp. *arboresenti* foliis ellipticis et undulatis differt.
Folia elliptica vel elliptico-oblanceolata, 0,8–1,5 (–2) cm lata, undulata, leviter succulenta et erecta.

Type: Cape, 1 km north of Sapkamma Station, *Tölken 4290* (BOL, holo!).

Leaves elliptic to elliptic-oblanceolate, 0,8–1,5 (–2) cm broad, undulate, slightly fleshy, erect.

On rocky slopes in sheltered kloofs in the southern parts of the Klein Winterhoek mountains.

This subspecies flowers in December and January as is typical for *C. arborescens*, while the very similar *C. ovata*, which occurs within a few kilometres of the type locality of the new subspecies, flowers during the period June to August.

CAPE—3325 (Port Elizabeth): 1 km north of Sapkamma Station (-AC), *Tölken 4290* (BOL); Paardepoort, near Glenconner Station (-AC), *Tölken 4299* (BOL).

5. **Crassula atropurpurea** (Haw.) Dietr., Syn. Pl. **2:** 1031 (1840). Iconotype: plate 780 (K, lecto!).
Globulea atropurpurea Haw. in Phil. Mag. **64:** 189 (1824); DC., Prodr. 3: 391 (1828).

This variable complex is viewed as one species with six divergent varieties, each of which occupies a somewhat different ecological niche but their ecological tolerances allow them to occur sufficiently close to one another with the result that extensive hybrid populations are found in some areas.

1 Leaves glabrous:
  2 Lateral branches with internodes more or less equal in length; peduncle with (2) 3–5 bracts without part-inflorescences . . **C. atropurpurea** var. **atropurpurea**
  2 Lateral branches with first internodes much longer than subsequent ones; peduncle with (0) 1 (2) pairs of bracts without part-inflorescences . . . . **C. atropurpurea** var. **cultriformis**
1 Leaves hairy:
  3 Leaves triangular to almost round in section . . **C. atropurpurea** var. **purcellii**
  3 Leaves dorsiventrally compressed:
    4 Leaves with recurved marginal cilia . . **C. atropurpurea** var. **rubella**
    4 Leaves without marginal cilia or if present then spreading:
      5 Petals with membranous apex curved downwards and with dorsal appendage in terminal position and more or less canaliculate . . . . **C. atropurpurea** var. **anomala**
      5 Petals without membranous apex and with terminal canaliculate fleshy rostrum:
        6 Lateral branches with first internodes much longer than subsequent ones; petals glabrous . . . . . **C. atropurpurea** var. **cultriformis**
        6 Lateral branches with internodes more or less equal in length; petals minutely papillose . . . . . . **C. atropurpurea** var. **watermeyeri**

—— var. **anomala** (Schonl. & Bak. f.) Toelken, comb. nov. et stat. nov.

C. anomala Schonl. & Bak. f. in J. Bot., Lond. **36:** 370 (1898); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 263 (1929). Type: Cape, French Hoek, *Schlechter* 9317 (GRA, holo!; BM!; BOL!; E!; G!; K!; P!; Z!).

—— var. **cultriformis** (Friedr.) Toelken, comb. nov. et stat. nov.

C. cultriformis Friedr. in Mitt. Bot. Staatssamml. München **6:** 638, fig. 9A (1967) et in Prodr. Fl. S. W. Afr. **52:** 27 (1968). Type: Cape, Holgat River, *Herre 4088* (M, holo).

—— var. **purcellii** (Schonl.) Toelken, comb. nov. et stat. nov.

C. purcellii Schonl. in Rec. Albany Mus. **2:** 148 (1907) et in Trans. Roy. Soc. S. Afr. **17:** 266 (1929). Type: Cape, Matjesfontein, *Purcell s.n.* (GRA, holo!).

—— var. **rubella** (Compton), Toelken, comb. nov. et stat. nov.

C. rubella Compton in Trans. Roy. Soc. S. Afr. **19:** 291 (1931). Syntypes: Cape, Witteberg, *Compton 2820* (BOL!); Whitehill, *Compton 2892* (BOL!).

—— var. **watermeyeri** (Compton) Toelken, comb. nov. et stat. nov.

C. watermeyeri Compton in J. Bot., Lond. **69:** 49 (1931). Type: Cape, near Nieuwoudtville, *Compton 3208* (BOL, holo!).

6. **Crassula ausensis** P. C. Hutch. subsp. **giessii** (Friedr.) Toelken, comb. nov. et stat. nov.

C. giessii Friedr. in Mitt. Bot. Staatssamml. **11:** 330, fig. 5 (1974). Type: South West Africa, Naukluft, *Merxmüller & Giess 28 956* (M, holo). The very short pedicels and usually ciliate leaves distinguish this subspecies from the typical one.

7. **Crassula barbata** Thunb. subsp. **broomii** (Schonl.) Toelken, comb. nov. et stat. nov.

C. broomii Schonl. in Rec. Albany Mus. **2:** 146 (1907). Type: Cape, Pampoenpoort, *Broom s.n.* (GRA, holo!).

The leaves are broadly obovate and these have marginal cilia only up to 0,1 cm long. The very large lateral stigma and the more or less distinct style found in the type specimen are variable characters in this subspecies and seem to depend on the stage of maturity of the carpels.

8. **Crassula brachystachya** Toelken, sp. nov. ab *C. obovata* foliis acutis et brevibus qui abrupte abbreviatis ad basim inflorescentiae, floribus sessilibus et appendice brevi in petalo differt.

Suffrutices perennes plerumque aliquot rosulis foliis spiraliter dispositis, caulibus succulentis et fragilibus 10–20 cm longis ubi florentibus et saepe radicantibus crassis sed non tuberosis. *Folia* sessilia, oblanceolato-elliptica, 2–4 (–8) cm longa, 0,5–1,5 (–2) cm lata, acuta gradatim constricta ad basim, dorsoventraliter complanata sed aliquantum succulentia, glabra sed ciliis subdistantibus, viridia vel saepe margine rubrotincto; vaginae foliorum 0,2–0,5 cm longa. *Hydathodes* in series una densa secus marginem superum et inferum et aliquot dispersae supra, vix visibles. *Inflorescentia* terminalis spiciformibus, floribus aliquot pentameris in dischasiis sessilibus, caulibus erectis glabris et bracteis folia similis. *Sepala* oblongo-elliptica, 3,5–4,5 mm longa, arista brevi in quoque apice acuto, glabra sed ciliis marginalibus, succulentia, viridia. *Petala* oblongo-ovata, 5–6 mm longa, acuta et appendice dorsali distincta in quoque petalo, connata et tubo c. 1 mm longa, apicibus loborum recurvis, alba. *Stamina* 4–5 mm longa, antheris nigris 0,8–1 mm longis, filamentis latis factis ad basim. *Squamae* transverse oblongae, 0,2–0,3 × 0,8–1 mm, plerumque truncatae, vix constrictae ad basim, leviter succulentae, flavae. *Carpella* ovariis gracilibus reniformibus, stylis tenuibus et stigmatibus terminalibus parvis; ovarium laevis et 26–34 ovulis elongatis et papillis serialibus.

Type: Cape, Wittekloof, *Compton 2819* (BOL, holo!).

Perennials with usually several rosettes with leaves spirally but loosely arranged at the end of fleshy and brittle branches 10–20 cm long when flowering and often with thick but not tuberous roots, with old leaves usually soon wearing off. *Leaves* sessile, oblanceolate-elliptic, 2–4 (–8) cm long, 0,5–1,5 (–2) cm broad, acute and gradually tapering towards the base, abruptly shortened on the erect branch which ends in the inflorescence, dorsiventrally flattened but somewhat convex, glabrous except for subdistant cilia which are rarely slightly recurved, green or often tinged red along the margin; sheath 0,2–0,5 cm long and formed by the partial fusion of the leaf bases. *Hydathodes* arranged

in a dense row along the upper and lower margin and few scattered over the upper surface, hardly visible. *Inflorescence* terminal, spike-like, with several 5-merous flowers in sessile dichasia, with a glabrous erect stem not distinguishable from a vegetative branch but with short leaf-like bracts. *Sepals* oblong-elliptic, 3,5–4,5 mm long, with acute apices often with a short awn, glabrous except for some marginal cilia, fleshy green. *Petals* oblong-obovate, 5–6 mm long, acute and each with a distinct dorsal appendage, fused into a tube c. 1 mm long, with apices of the lobes recurved, white. *Stamens* 4–5 mm long, with black anthers, 0,8–1 mm long and longer than broad, with filaments somewhat broadened towards the base and constricted where fused to the petal tube. *Squamae* transversely oblong, 0,2–0,3 × 0,8–1 mm, usually truncate, somewhat constricted towards the base, slightly fleshy, yellow. *Carpels* with slender reniform ovaries and with long thin styles half to two-thirds of the length of the ovaries and with small terminal stigmas; ovary smooth and with 26–34 elongate ovules covered with rows of papillae.

In moist shaded rock crevices on rock faces in ravines and recorded only from the north-eastern Witteberg and northern Swartberg.

CAPE—3320 (Montagu): Wittekloof (-BD), *Compton 2819* (BOL); Pieter Meintjies (-AD), *Marloth 9987* (PRE).
—3321 (Ladismith): west of Bosluiskloof (-AD), *Tölken 4106* (BOL).
—3322 (Oudtshoorn): near Prince Albert (-AA), *Stokoe s.n.* (BOL).

9. **Crassula brevifolia** Harv. subsp. **psammophila** Toelken, subsp. nov. ab subsp. *brevifolia* caulibus et foliis latis, carpellis laevibus et ovulis 10–12; ab *C. macowaniana* apicibus obtusis foliorum et sepalis acutis differt.

Fruticuli usque ad 20 cm alti, caulibus effusis vel decumbentibus, parum ramosi, internodiis inter folia brevissimis et caulibus infra partem foliis (0,3) 0,4–0,5 cm lata, obtusa, patentia, glaucesentia vel saepe fusca. *Inflorescentia* corymbo-thyrsus, pedunculo 4–8 cm longo, bracteis anguste triangularibus plerumque longioribus 2 mm. *Petala* oblonga, crista dorsale sed sine appendice dorsale in quoque petalo, alba suffosa rosea. *Antherae* atro-purpureae. *Carpella* laevia et 10–12 ovulis.

Type: Cape, hills along the Kammas River on the road between Port Nolloth and the Grootmis, *Tölken 4004* (BOL, holo!).

Shrublets up to 20 cm high, with spreading branches rarely decumbent, little branched, with internodes between the leaves not visible and branches below the region with leaves (0,3–) 0,4 cm in diameter. *Leaves* (2–) 2,5–4 cm long, (0,3–) 0,4–0,5 cm broad, with rounded apex, straight and spreading at about right angles to the stem, dull green or more often brownish-red and without bloom. *Inflorescence* an almost flat-topped thyrse, with a peduncle 4–8 cm long, with narrowly triangular bracts usually longer than 2 mm and longer than broad. *Petals* oblong and each with a dorsal ridge but usually without dorsal appendage, white tinged pink. *Anthers* dark purple. *Carpels* glabrous and with 10–12 ovules.

CAPE—2816 (Oranjemund): Peacock's Bay (-DA), *Tölken 3368* (BOL); Holgat River (-DD), *Tölken 1855* (BOL).

—2916 (Port Nolloth): along Kammas River (-BB), *Tölken 3465* (BOL); 4404 (BOL). Springbok ?, *Herre* in SUG *5879* (GRA).

10. **Crassula campestris** (Eckl. & Zeyh.) Endl. ex Walp. subsp. **pharnaceoides** (Fisher & C. A. Mey.) Toelken, comb. nov. et stat. nov.

Crassula pharnaceoides Fischer & C. A. Mey. in Ind. Sem. Hort. Petrop. **8:** 56 (1841); Walp., Rep. **2:** 254 (1843); Friedr. in Prodr. Fl. S. W. Afr. **52:** 33 (1968). Type: Abyssinia, near Adoa, *Schimper s.n.* (B!; G!; GRA!; P!; S!). *Tillaea pharnaceoides* (Fisher & C. A. Mey.) Steudel, Nomencl. Bot. ed. 2, **2:** 687 (1841); Britt., Fl. Trop. Afr. **2:** 387 (1871).

The seeds of this subspecies are about twice as long as broad while they are scarcely longer than broad in the subsp. *campestris.*

Both Fischer & C. A. Meyer and Steudel derived their name from a printed label inscribed *Tillae pharnaceoides* but without description by Hochstetter. Fischer and Meyer described it as a species of *Crassula* so that Steudel's reference eight months later can be construed as a new combination, as it is based on the same type material.

11. **Crassula capensis** (L.) Baill. var. **albertiniae** (Schonl.) Toelken, comb. nov. et stat. nov.

C. albertiniae Schonl. in Ann. Bolus Herb. **2:** 93 (1917) et in Trans. Roy. Soc. S. Afr. **17:** 207 (1929). Type: Cape, Onverwacht, *Muir* 1315 (GRA, holo!).

—— var. **promontorii** (Schonl. & Bak. f.) Toelken, comb. nov. et stat. nov.

C. promontorii Schonl. & Bak. f. in J. Bot., Lond. **36:** 366 (1898) et in Trans. Roy. Soc. S. Afr. **17:** 204 (1927). Type: Cape, Kasteelberg, *Wolley Dod 1624* (GRA, holo!; SAM!).

The var. *promontorii* is distinguished from the typical variety by the absence of a peduncle while the var. *albertiniae* is characterized by its leaves with entire margin and they are often produced after flowering.

12. **Crassula capitella** Thunb. subsp. **capitella**

C. capitella Thunb. in Acta Nova Phys.-Med. Acad. Caes. Leop.-Carol., Nat. Cur. **6:** 330, 339 (1778) et Fl. Cap. ed. Schultes 286 (1823); L. f., Suppl. 190 (1781); Ait., Hort. Kew. ed. 1, **1:** 394 (1789). Type: Cape, between Cannaland and Olifant's River, *Thunberg* in Herb. Thunberg *7732a* (UPS, lecto!).

C. spicata Thunb. in Acta Nova Phys.-Med. Acad. Caes. Leop.- Carol., Nat. Cur. **6:** 329, 333 (1778) et Fl. Cap. ed. Schultes 284 (1823); L. f., Suppl. 189 (1781). Type: Cape, Karoo, *Thunberg* in Herb. Thunberg *7796* (UPS, holo!).

Although *C. capitella* and *C. spicata* were described by Thunberg in the same publication the former name is prefered because it represents the more commonly found form of this species.

C. capitella is treated here as a species complex with five different subspecies which show an almost complete range from shrubs, to perennials with a basal rosette, to biennials. The petal apices vary from recurved to erect with the dorsal appendages becoming more enlarged and eventually being found in the terminal position.

1 Petal with smooth appendage in terminal position:
  2 Bracts subtending the part-inflorescences glabrous; squamae emarginate . . . **C. capitella** subsp. **capitella**
  2 Bracts subtending part-inflorescences densely hairy; squamae truncate . . . . **C. capitella** subsp. **nodulosa**
1 Petal with denticulate appendage in dorsal position:
  3 Sepals covered with recurved hairs and marginal cilia; squamae oblong . . . **C. capitella** subsp. **enantiophylla**
  3 Sepals glabrous or with a few marginal teeth; squamae transversely oblong to square:
    4 Leaves with obtuse or rounded apices; petals scarcely recurved . . . **C. capitella** subsp. **meyeri**
    4 Leaves with acute apices; petals recurved to about half their length . . **C. capitella** subsp. **thyrsiflora**

—— subsp. **enantiophylla** (Bak. f.) Toelken, comb. nov. et stat. nov.
C. enantiophylla Bak. f. in Bull. Herb. Boiss. ser. 2, **3:** 816 (1903). Type: Transvaal, Houtbos, *Rehmann 6372* (Z, holo!; BM!).

—— subsp. **meyeri** (Harv.) Toelken, comb. nov. et stat. nov.
C. meyeri Harv., Fl. Cap. **2:** 344 (1862). Type: Natal, between the Omsamculo and Omcomas Rivers, *Drege s.n.* (S, holo!; G!; P!).

—— subsp. **nodulosa** (Schonl.) Toelken, comb. nov. et stat. nov.
C. nodulosa Schonl. in Rec. Albany Mus. **1:** 56 (1903) et in Trans. Roy. Soc. S. Afr. **17:** 247 (1929). Type: Cape, Warrenton, *Adams 28* (GRA, holo!; PRE!; SAM!).

—— subsp. **thyrsiflora** (Thunb.) Toelken, comb. nov. et stat. nov.
C. thyrsiflora Thunb. in Acta Nova Phys.-Med. Acad. Caes. Leop.-Carol., Nat. Cur. **6:** 329, 339 (1778) et Fl. Cap. ed. Schultes 283 (1821); L. f., Suppl. 190 (1781). Type: Cape, between Sundays and Fish River, *Thunberg* in Herb. Thunberg *7801* (UPS, holo!).
C. turrita Thunb. in Acta Nova Phys.-Med. Acad. Caes. Leop.-Carol., Nat. Cur. **6:** 329, 336 (1778) et Fl. Cap. ed. Schultes 285 (1823); L. f., Suppl. 189 (1781). Type: no type preserved.

13. **Crassula congesta** N.E. Br. subsp. **laticephala** (Schonl.) Toelken, comb. nov. et stat. nov.
C. laticephala Schonl. in Rec. Albany Mus. **2:** 457 (1913). Type: Cape, Riversdale, *Volschenk s.n.* (GRA, holo!; K!; SAM!).

The subsp. *congesta* which occurs to the north of the Witteberge is distinguished by its blunt leaf apices which are curved upwards, while the subsp. *laticephala* with its acute recurved leaf apices occurs to the south-east of these mountains.

14. **Crassula corallina** Thunb. subsp. **macrorrhiza** Toelken, subsp. nov. ab subsp. *corallina* radicibus principalibus tuberosis 0,3–0,8 (–1,2) cm in diametro, ramis sine radicibus adventiis et carpella stylis distinctis differt.
C. corallina sensu Higgins in J. S. Afr. Bot. **24:** 115–118, fig. 2A (1958); sensu Friedr. in Prodr. Fl. S. W. Afr. **52:** 26 (1968), non Thunb.
Plantae caulibus brevis erectis vel longioribus decumbentibus et sine radicibus adventiis vel rare solum in node singulare, radicibus principalibus tuberosis 0,3–0,8 (–1,2) cm in diametro. *Folia* angulato-obovata, fere obtriangularia, 0,4–0,5 cm longa, (0,35–) 0,4–0,5 cm lata, plerumque obtusa, texta strato cerae in paginis exposis. *Carpella* stylis distinctis ovariis recurvis ad apicem et stigmatibus sessilibus lateralibus.

Type: South West Africa, Klein Karas, *Dinter 4773* (PRE, holo!; K!).

Plants with short erect, or with longer decumbent or prostrate stems which are usually without adventitious roots, or, if present, then only at a single node at a time, with tuberous main roots 0,3–0,8 (–1,2) cm in diameter. *Leaves* angular-obovate to almost obtriangular, 0,4–0,5 cm long, (0,35–) 0,4–0,5 cm broad and usually with rounded apex, covered with a white waxy layer on the exposed surfaces. *Carpels* with indistinct styles and the broad upper part of the ovary recurved at the apex and with sessile lateral stigmas.

The subsp. *macrorrhiza* is restricted to Bushmanland and south-eastern South West Africa.

SOUTH WEST AFRICA—2718 (Grunau): Klein Karas (-CA), *Dinter 4773* (PRE, K).
—2818 (Warmbad): Warmbad (-BC), *Herre* in SUG *5773* (GRA).
CAPE—2717 (Vioolsdrif): Stinkfontein Plateaux, *Pearson 6204* (GRA).
—*2818* (Warmbad): 20 km east-south-east of Goodhouse (-CD), *Tölken 3681* (BOL).
—2820 (Kakamas): Kakamas (-DC), *Fuller 32* (BOL).
—2821 (Upington): Upington (-AC), *Simpson s.n.* (NBG).
—2917 (Springbok): 40 km north of O'Okiep (-BD), *Horrocks 17* (NBG).
—2918 (Gamoep): Aggenys (-BB), *Pearson 2945* (BOL, GRA, SAM).

—2919 (Pofadder): near Pofadder (-AB), *Barker 8357* (NBG).
—2921 (Kenhardt): 4 km west of Kenhardt (-AC), *Acocks 16 507* (PRE).

15. **Crassula decumbens** Thunb. var. **brachyphylla** (Adamson) Toelken, comb. nov. et stat. nov.

C. brachyphylla Adamson in J. S. Afr. Bot. **8:** 276 (1942). Type: Cape, Devil's Peak, *Ecklon & Zeyher 1852* (G!; GRA!; K!; S!; S!; SAM!).

The var. *brachyphylla* is usually distinguished from the typical variety by its club-shaped leaves and the broadly ovate petals, but plants from Bredasdorp are very similar to those of the var. *decumbens*.

16.**Crassula elegans** Schonl. & Bak. f. subsp. **namibensis** (Friedr.) Toelken, comb. nov. et stat. nov.

C. namibensis Friedr. in Mitt. Bot. Staatssamml. München **6:** 632, fig. 5 (1967) et in Prodr. Fl. S. W. Afr. **52:** 33 (1968). Type: South West Africa, Lüderitzbucht, *Merxmüller & Giess 3477* (M, neo).

The subsp. *namibensis* occurs in rock outcrops near Luderitz Bay and is distinguished from the typical subspecies by its blunt somewhat swollen trichomes on the leaves.

17. **Crassula elsieae** Toelken, sp. nov. ab *C. corallina* hydathodis marginalibus, squamis oblongo-cuneatis, habitione; ab *C. papillosa* foliis obovatis et sepalis oblongis differt.

Herbae perennes ramis prostratis vel decumbentibus usque ad 10 cm longis et rare 0,1 cm in diametro latioribus et non lignosis ad basim, radicibus adventiis secus ramum, foliis veteribus non caducis. *Folia* sessilia, obtusa et saepe aliquantum angulata, 0,2 0,4 cm longa, 0,2–0,3 mm lata et basi cuneata plana sed succulentescentia ad apicem, minute papillosa saltem ubi juvenia, viridia vel fusca; vaginae foliorum circiter 0,05 mm longa et membranacea. *Hydathodi* aliquot plus minusve seriales in marginibus foliorum, vix visibiles. *Inflorescentia* dichasium terminale (1–) 3–5 floribus pedicellatis et pentameris, pedunculo indistincto et bracteis ellipticis succulentibus. *Sepala* late oblonga, 1,5–2 mm longa, obtusa, succulenta, viridia. *Petala* oblonga vel oblanceolata, 2,5–3 mm longa, obtusa sine appendicibus dorsalibus, connata in tubum 0,2–0,4 mm longem, loborum apicis recurvis, albis vel eburneis. *Stamina* circiter 2 mm longa, antheris luteis 0,2–0,3 mm longis, filamentis aliquantum latentibus ad basim et vix constrictis ubi connatis petalorum tubo. *Squamae* oblongo-cuneatae, 0,4–0,6 × 0,3–0,4 mm, truncatae et aliquantum constrictae ad basim, vix succulentae, pallide flavae. *Carpella* ovariis late reniformibus gradatim constrictis in stylos breves stigmatibus terminalibus indistinctis; ovarium laeve et 4–6 ovulis elongatis dense tectum papillis serialis saepe indistinctis.

Type: Cape, Krakadouw Peak, *Esterhuysen 14 958* (BOL, holo!).

Perennials with prostrate or decumbent branches up to 10 cm long and rarely more than 1 cm in diameter and not woody towards the base, with adventitious roots along the stem, with old leaves remaining attached to the stem. *Leaves* sessile, obovate and often somewhat angular, 0,2–0,4 cm long, 0,2–0,3 mm broad, obtuse and with a cuneate base, flat but becoming more fleshy towards the apex, minutely papillose at least when young, green to brown; sheath c. 0,05 mm long and membranous. *Hydathodes* few, more or less clearly arranged in a row on the margin of the leaves, hardly visible. *Inflorescence* a terminal dichasium with (–1) 3–5 flowers pedicellate and 5-merous, with peduncle hardly distinguishable from the vegetative branches and with fleshy elliptic bracts. *Sepals* broadly oblong, 1,5–2 mm long, with rounded apex, fleshy green. *Petals* oblong to oblanceolate, 2,5–3 mm long, obtuse and without dorsal appendage, fused into a tube 0,2–0,4 mm long with apices of the lobes recurved, white or cream. *Stamens* c. 2 mm long, with yellow anthers 0,2–0,3 mm long, with filaments slightly broadened towards the base and hardly constricted where fused to the petal tube. *Squamae* oblong-cuneate, 0,4–0,6 × 0,3–0,4 mm, truncate and somewhat constricted towards the base, slightly fleshy, pale yellow. *Carpels* with broadly reniform to almost pear-shaped ovaries gradually constricted into short styles with indistinct terminal stigmas; ovary smooth and with 4–6 elongate ovules densely covered with often indistinct rows of papillae.

In shaded places under rocks or in rock basins and known only from the northern Cedarberg.

This species is very rare and all the plants recorded of it were collected by the very observant collector Miss Elsie Esterhuysen, in honour of whom the species is named.

CAPE—3219 (Wuppertal): Krakadouw Peak (-AA), *Esterhuysen 14 958* (BOL); Krakadouwsberg (-AA), *Esterhuysen 7517* (BOL).

18. **Crassula ericoides** Haw. subsp. **tortuosa** Toelken, sp. nov. ab subsp. *ericoides* prostrato habitu et ovariis ovulis quatuor differt.

Plantae prostratae vel decumbentes, ramis precique ex base et ramis principalibus tortuosis. *Folia* (0,2–) 0,3–0,4 cm longa rare usque ad 0,1 cm lata et foliis veteribus remanentibus in ramis. *Petala* 0,2–0,3 cm longa, aliquantum expansa et saepe leviter recurva. *Carpella* circiter 0,2 cm longa et ovulis quatuor.

Type: Cape, top of Prince Alfred's Pass, *Tölken 3757* (BOL, holo!).

Plants prostrate or decumbent, branching mainly from the base and with main branches usually tortuous. *Leaves* (0,2–) 0,3–0,4 cm long, rarely broader than 0,1 cm and old leaves remaining attached to the branches for some time. *Petals* 0,2–0,3 (–0,4) cm long, spreading and often slightly recurving. *Carpels* c. 0,2 cm long and with 4 ovules.

On shallow soil on rocks at high altitude in the mountains from the Great Winterhoek to the Outeniqua mountains.

CAPE—3321 (Ladismith): Cloetes Pass (-DD), *Zinn* in SAM *59 071.*
—3322 (Oudtshoorn): Spitskop (-BC), *Thorne* in SAM *51 442.*
—3323 (Willowmore): top of Prince Alfred Pass (-CC), *Tölken 3757* (BOL); near Joubertina (-DD), *Esterhuysen 13 648* (BOL).
—3324 (Steytlerville): Winterhoek mountains, *Zeyher 2523* (PRE, SAM).

19. **Crassula exilis** Harv. subsp. **exilis**
C. exilis Harv., Fl. Cap. **2:** 347 (1862); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 252 (1929). Type: Cape, Namaqualand, *Whitehead s.n.* (TCD, holo!).

C. exilis has often been wrongly interpreted as its typical form has very fleshy leaves and a clearly defined peduncle, unusual features within the section *Rosulares*, but the variation within the species complex shows a complete range of these characters.

1 Peduncle with short spreading blunt hairs (usually not visible without lens) . . . . . **C. exilis** subsp. **exilis**
1 Peduncle glabrous . . . . **C. exilis** subsp. **sedifolia**
1′ Peduncle with spreading slightly recurved hairs c. 1 mm long . . **C. exilis** subsp. **cooperi**

—— subsp. **sedifolia** (N. E. Br.) Toelken, comb. nov. et stat. nov.
C. sedifolia N. E. Br. in Gard. Chron. ser. 3, **32:** 429 (1902); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 236 (1929). Type: South Africa without precise locality, *MacOwan s.n.* (K, holo!).

—— subsp. **cooperi** (Regel) Toelken, comb. nov. et stat. nov.
C. cooperi Regel in Gartenflora 36, t. 786 (1874); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 236 (1929). Type: South Africa, without precise locality. (LE, holo!).

20. **Crassula expansa** Dryand. in Ait. subsp. **expansa**
C. expansa Dryand. in Ait., Hort. Kew. ed. 1, **1:** 390 (1789); Harv., Fl. Cap. **2:** 354 (1862); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 184 (1929). Type: Caput Bonae Spei, *Masson s.n.* (BM, holo!).

This very variable species complex of which five different subspecies occur in Southern Africa is very widespread in Africa. Some of the subspecies often occur geographically very close to one another but usually remain ecologically isolated.

1 Sepals and leaves covered with spreading hairs:
    2 Hydathodes on margin of leaves; moist places on Swartberg . . . . **C. expansa** subsp. **peculiaris**
    2 Hydathodes scattered over the upper leaf surface; northern Natal and Transvaal **C. expansa** subsp. **fragilis**

1 Sepals and leaves glabrous:

3 Leaves with one or two rows of hydathodes; stems without adventitious roots; widespread from northern Natal to southern and northern Cape . . . . . **C. expansa** subsp. **expansa**

3 Leaves usually with two rows of hydathodes; stems with woody adventitious roots; along the coast from Port Elizabeth to the Cape Peninsula . . . . **C. expansa** subsp. **filicaulis**

3' Leaves with hydathodes scattered at least over the upper surface; stems usually with adventitious roots; Namaqualand and into south-western South West Africa **C. expansa** subsp. **pyrifolia**

—— subsp. **filicaulis** (Haw.) Toelken, comb. nov. et stat. nov.
C. filicaulis Haw. in Phil. Mag. **24:** 187 (1824); DC., Prodr. **3:** 384 (1828); Eckl. & Zeyh., Enum. 295 (1837), partly. Iconotype: plate 768 (K, lecto!).

—— subsp. **fragilis** (Bak.) Toelken, comb. nov. et stat. nov.
C. fragilis Bak. in J. Linn. Soc. (Bot.) **22:** 469 (1887). Type: central Madagascar, *Baron 3348* (K, holo!).
C. browniana Burtt Davy, Fl. Transv. 141 (1925); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 185 (1929). Type: Transvaal, near Lydenburg, *Wilms 518* (K, holo!).

—— subsp. **peculiaris** Toelken, subsp. nov. ab subspeciebus aliis foliis hirsutis et radicibus non gralliformibus; ab subsp. *fragile* floribus axillaribus et habitate altitudine differt.
Herbae perennes ramis prostratis usque ad 30 cm longes et interdum radicis adventiis gracilibus. *Folia* petiolis usque ad 0,3 cm longis; lamina ovata vel late elliptica (0,2–) 0,4–0,6 cm lata, dorsoventraliter complanata, tecta pilis gracilibus et hydathodis paucis secus margines. *Flores* singulares in axilis foliorum et saepe non ad apices ramorum. *Sepala* longitudine c. 3/4 petalis partes aequantia, acuta vel obtusa et pubescentia.

Type: Cape, east of Oliewenberg, *Esterhuysen 28 832* (BOL, holo!).

Perennials with prostrate herbaceous branches up to 30 cm long, forming irregular mats and sometimes with fine adventitious roots. *Leaves* with petioles up to 0,3 cm long; lamina ovate to broadly elliptic, (0,2–) 0,4–0,6 cm broad, dorsiventrally compressed, covered with long fine hairs and with few hydathodes along the margin. *Flowers* borne singly in the axils of the leaves and often not even at the apical part of the stem. *Sepals* three-quaters of the length of the petals, bluntly acute and covered with scattered hairs.

On moist shaded areas and usually under rocks at an altitude of above 1 500 m and recorded only from the vicinity of the Swartberg Pass.

CAPE—3322 (Oudtshoorn): Swartberg Pass (-AC), *Esterhuysen 4559* (BOL); east of Oliewenberg (-AC), *Esterhuysen 28 832* (BOL).

——subsp. **pyrifolia** (Compton) Toelken, comb. nov. et stat. nov.
C. pyrifolia Compton in J. Bot. Lond. **70:** 283 (1932). Type: Cape, near Bitterfontein, *Moller* sub Compton *3954* (BOL, holo!; K!).

21. **Crassula garibina** Marl. & Schonl. subsp. **glabra** Toelken, subsp. nov. ab subsp. *garibina* foliis glabris vel rare papillis minutis sine apicibus sphaericis differt.
Plantae praeter calycem minute papillosam glabrae. *Folia* viridia vel viridi-flava et glabra rare juvenilia minute papillosa.

Type: Cape, Geselskapbank, *Tölken 3687* (BOL, holo!).

Plants glabrous except for minutely papillose calyx. *Leaves* green to yellowish-green and glabrous or rarely minutely papillose when young.
CAPE—2917 (Springbok): Eenriet mountain (-BB), *Smithers s.n.* (BOL); 10 km north of Steinkopf (-BB), *Tölken 4324* (BOL).
—2918 (Gamoep): Geselskapbank (-AA), *Tölken 3687* (BOL).

22. **Crassula globularioides** Britt. subsp. **argyrophylla** (Schonl. & Bak. f.) Toelken, comb. nov. et stat. nov.
C. argyrophylla Diels ex Schonl. & Bak. f. in J. Bot., Lond. **40:** 290 (1902); Diels in Bot. Jahrb. **39:** 465 (1907); Burtt Davy, Fl. Transv. 141 (1926). Syntypes: Transvaal, Braamfontein, *Gilfillan* sub Galpin *6211* (GRA!; BOL!; PRE!); Lydenburg, *Wilms 527* (BM!)

—— subsp. **illichiana** (Engl.) Toelken, comb. nov. et stat. nov.
C. illichiana Engl. in Diels et Engl. in Bot. Jahrb. **39:** 465 (1907). Syntypes: Tanzania, Usambara, *Buchwald 174* (K!); Manca near Sakara, *Engler 1073* (B).

The subsp. *argyrophylla* is distinguished from the very similar subsp. *illichiana* by only one bract without part-inflorescences on the peduncle, and its marginal cilia becoming shorter towards the base of the leaves.

23. **Crassula grammanthoides** (Schonl.) Toelken, comb. nov. et stat. nov.
Dinacria grammanthoides Schonl. in Bull. Herb. Boiss. ser. 1, **5:** 859 (1897). Type: Cape, Swartberg near Caledon, *Schlechter 5570* (GRA, holo!; BOL!).

C. grammanthoides is very similar to *C. depressa* except that instead of a terminally placed stigma it is here in a lateral position. This represents an intermediate stage between species of *Crassula*, such as *C. depressa*, and *Dinacria filiformis* and *Dinacria sebaeoides* where the styles are variously enlarged to bring the stigma into a lateral position.

24. **Crassula lanuginosa** Harv. var. **pachystemon** (Schonl. & Bak. f.) Toelken, comb. nov. et stat. nov.

C. pachystemon Schonl. & Bak. f. in J. Bot., Lond., **36:** 367 (1898); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 258 (1929). Type: Cape, near Graaff Reinet, *Bolus 437* (GRA, lecto!; K!; PRE!).

C. ernestii Schonl. & Bak. f. in J. Bot., Lond. **40:** 283 (1902); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 258 (1929). Type: Cape, Bowker's Park, *Galpin 2563* (GRA, holo!; BM!).

The var. *lanuginosa* is distinguished from the typical variety by its usually smaller leaves with an acute apex and one to few terminal hairs. The two varieties occur without any intermediates in the vicinity of Cradock but between Tarkastad and Queenstown some intermediates have been found.

25. **Crassula latibracteata** Toelken, sp. nov. ab *C. cultrata* et *C. rogersio* petalis oblongo-oblanceolatis et thyrso capitato circumcinato bracteis late oblanceolatis differt.

Frutices perennes usque ad 40 cm alti, plerumque multum ramosi et ramis superis rectis et erectis, infernis saepe decumbentibus 0,1–0,3 cm in diametro et cortice chartaceo, foliis veteribus deciduis. *Folia* sessilia, obovata vel aliquantum falcata, (0,8–) 1–2 (–2,5) cm longa, 0,4–0,7 cm lata, obtusa dorsoventraliter complata et leviter convexa sed marginibus argutis, puberula vel glabra, viridia ad lutea-viridia et saepe marginibus corneis rubris; vaginae foliorum 0,1–0,2 cm longae. *Hydathodi* diespersae in paginis superibus et infernis, conspicuae. *Inflorescentia* thyrsus terminalis densus et fere capitatus 1–2 dichasiis floribus pentameris sessilibus, pedunculo puberulo vel glabrescente 15–25 cm longo, bracteis obovatis ad late oblongis saepe marginibus membraneis et obtangentibus inflorescentiis. *Sepala* oblongo-triangularia, 2–2,5 mm longa, obtusa, succulentissima ad apicem, puberula, viridia vel luteoviridia. *Petala* oblonga vel oblongo-oblanceolata, 3–3,5 mm longa, appendicibus dorsalibus elongatis, 0,5–0,8 mm connata, eburnea. *Stamina* 2,5–3 mm longa, antheris luteis 0,5–0,8 mm longis, filamentis non latioribus ad basim et aliquantum constrictis ubi connatis tubo petalorum. *Squamae* oblongo-cuneatae, 0,6–0,8 × 0,4–0,6 mm, truncatae vel leviter emarginatae, plerumque aliquantum constrictae ad basim, leviter succulentae, luteae. *Carpella* ovariis reniformibus abrupte constrictis ad styles breves crassos stigmatibus latis viridibus et saepe aliquantum lateralibus; ovarium ciliis brevibus secus suturam et 10–14 ovulis elongatis porcis leviter papillosis.

Type: Cape, Riebeeck East, *Tölken 4344* (BOL, holo!).

Perennials forming shrublets up to 40 cm high, usually much branched and with upper branches erect and straight, with lower branches often wiry and decumbent 0,1–0,3 cm in diameter and with peeling bark, with old leaves deciduous. *Leaves* sessile, obovate to somewhat falcate and turned to the one

side of the stem, (0,8–) 1–2 (–2,5) cm long, 0,4–0,7 cm broad, with rounded apex, dorsiventrally flattened and slightly convex on either surface but with sharp margins, puberulous to glabrous, green to yellowish-green and often with red horny margin; sheath 0,1–0,2 cm long and formed by the partial fusion of the leaf bases. *Hydathodes* scattered over the upper and lower leaf margin, more or less conspicuous. *Inflorescence* a terminal dense almost capitate thyrse with one to three dichasia with sessile 5-merous flowers, with peduncle puberulous to glabrascent 15–25 cm long with obovate to broadly oblong bracts often with a membranous margin covering the lower parts of the inflorescence. *Sepals* oblong-triangular, 2–2,5 mm long, with rounded apices often very swollen so that it appears to be recurved, puberulous, green to yellowish-green. *Petals* oblong to oblong-lanceolate, 3–3,5 mm long, each with elongate dorsal appendage in terminal position, fused into a tube 0,5–0,8 mm long, with short swollen apices curved downwards, cream. *Stamens* 2,5–3 mm long, with yellow anthers 0,5–0,8 mm long, with filaments not broadened towards the base and somewhat constricted where fused to the petal tube. *Squamae* oblong-cuneate, 0,6–0,8 × 0,4–0,6 mm, truncate or slightly emarginate, usually somewhat constricted towards the base, slightly fleshy, yellow. *Carpels* with reniform ovaries abruptly constricted into short stout styles ending in broad green and somewhat laterally placed stigmas; ovary with short cilia along the suture and with 10–14 elongate ovules covered with faintly papillose ridges.

CAPE—3226 (Fort Beaufort): Adelaide (-BC), *Rogers 27 680* (PRE).
—3325 (Port Elizabeth): Suurberg (-BD), *Barker 4941* (NBG).
—3326 (Grahamstown): Riebeeck East (-AA), *Tölken 4344* (BOL); near Southwell (-CA), *Acocks 11 086* (PRE).

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26. **Crassula mesembryanthoides** (Haw.) Dietr. subsp. **hispida** (Haw.) Toelken, comb. nov. et stat. nov.

Globulea hispida Haw. in Phil. Mag. **66:** 30 (1825). Iconotype: plate 762 (K, lecto!).

Crassula hispida (Haw.) Dietr., Syn. Pl. **2:** 1031 (1840).

The internodes are very short (0,3–0,5 cm long) at the base of the branches in the subsp. *hispida* while they are usually 1–1,5 cm long in the subsp. *mesembryanthoides*. p173 4 p127

27. **Crassula minuta** Toelken, sp. nov. ab *C. vaillantio* sepalis petales aequantibus et squamis transverse oblongis et abrupte cuneatis; ab *C. decumbenti* foliis ad 3 mm longes et floribus terminalibus differt. 5 p

Herbae annuae ramis erectis 1–3 cm longis leviter rigidis, glabrae, internodiis aequalibus. *Folia* sessilia, linearia vel elliptica, 0,1–0,2 (–0,3) cm longa, 0,05–0,1 cm lata, plerumque obtusa, plus minusve plana supra et convexa subtus, glabra, succulenta, viridia vel testacea; vaginae foliorum c. 0,05 cm longa, membranacea.

Hydathodi paucae secus marginem, inconspicuae. *Inflorescentia* plerumque flores singulares terminales et pedicellis brevibus. *Sepala* elliptico-lanceolata, 1–1,5 mm longa, acuta, glabra, viridia vel testacea. *Petala* lanceolata, 1–1,5 mm longa, obtusa et sine appendicibus dorsalibus, connata tubo ad 0,3 mm longam, effusa alba vel eburnea et saepe rubrotincta. *Stamina* c. 1 mm longa, antheris flavis c. 0,1 mm longis et latis, filamentis vix latis factis ad bases. *Squamae* transverse oblongatae et abrupte cuneatae, 0,4–0,5 × 0,5–0,6 mm, truncatae abrupte constrictae ad bases, paene membranaceae, pallide flavae vel albae. *Carpella* ovariis oblongo- reniformibus gradate constrictis ad styles breves et stigmatibus terminalibus; ovarium leve et 2–4 ovulis elongatis leviter papillosis.

Type: Cape, Scorpionsberg, *Esterhuysen 12 233* (BOL, holo!; PRE!).

Annuals with erect branches 1–3 cm long and usually more or less wiry, glabrous, with pairs of leaves at about equal distances from one another. *Leaves* sessile, linear-elliptic, 0,1–0,2 (–0,3) mm long, 0,05–0,1 cm broad, usually obtuse, more or less flat above and convex below, glabrous, fleshy, green to reddish-brown; sheath c. 0,05 cm long, membranous. *Hydathodes* few along the margin, inconspicuous. *Inflorescence* usually single 4-merous flowers on short pedicels at the end of branches. *Sepals* elliptic- lanceolate, 1–1,5 mm long, bluntly, acute, glabrous, green to reddish-brown. *Petals* lanceolate, 1–1,5 mm long, obtuse and without dorsal appendages, fused into a tube 0,3 mm long, spreading, white or cream and often tinged red. *Stamens* c. 1 mm long and broad, with filaments scarcely broadened downwards and hardly fused to the tube. *Squamae* transverely oblong and abruptly cuneate, 0,4–0,5 × 0,5–0,6 mm, truncate, abruptly constricted towards the base, almost membranous, pale yellow or white. *Carpels* with oblong-reniform ovaries gradually constricted into short styles and with terminal stigmas; ovary smooth and with 2–4 elongate ovules which are faintly papillose.
CAPE—3219 (Wuppertal): Scorpionsberg (-AC), *Esterhuysen 12 233* (BOL, PRE); Tafelberg (-AC), *Esterhuysen 13 854* (BOL).

28. **Crassula montana** Thunb. subsp. **quandrangularis** (Schonl.) Toelken, comb. nov. et stat. nov.
C. quadrangularis Schonl. in Rec. Albany Mus. **1**: 57 (1903). Type: Cape, Laingsburg, *Marloth 2512* (GRA, holo!).

The squamae are scarcely constricted towards the base and the inflorescence is a flat-topped thyrse in the subsp. *quadrangularis*.

29. **Crassula multicava** Lem. subsp. **floribunda** Friedr. ex Toelken, subsp. nov. ab subsp. *multicava* inflorescentia floribus pentameris et sine gemmis adventitis differt.

Plantae erectae ramis rigidis 0,3–0,6 cm in diametro ubi foliis et glabrae vel hirsutae. *Inflorescentia* dichasiis floribus multis, braceis liniaribus apicibus obtusis, sine gemmis adventitis et floribus pentameris. *Petala* 5–6 mm longa et remanentia post florescentiam, alba vel eburnea. *Ovula* elongata et circiter dupla longiora suo diametro, tecta seriebus papillarum acutarum.

Type: Natal, old Tugela bridge (-AB), *Strey 4209* (PRE, holo!; NH!).

Plants erect with stiff branches 0,3–0,6 cm in diameter when with leaves, and the whole plant glabrous to hairy. *Inflorescence* with many-flowered dichasia with narrowly oblong bracts with blunt apices, without adventitious buds, with 5-merous flowers. *Petals* 5–6 mm long, recurved and remain so after flowering, white or off-white. *Ovules* elongate to about twice as long as broad, covered with rows of pointed papillae.
NATAL—2931 (Stanger): old Tugela bridge (-AB), *Strey 4209* (NH, PRE).
2930 (Pietermaritzburg): Inanda (-DB), *Wood 597* (BOL, SAM). Durban Botanic Gardens, *Wood 11 744* (NH, PRE, SAM).

30. **Crassula multiflora** Schonl. & Bak.f. subsp. **leucantha** (Schonl. & Bak.f.) Toelken, comb. nov. et stat. nov.

C. leucantha Schonl. & Bak.f. in J. Bot., Lond. **36:** 369 (1898); Schonl. in Trans. Roy. Soc. S. Afr. **17**: 262 (1929). Type: Cape, Houwhoek, *Schlechter 7378* (GRA, holo!; BM!; BOL!; G!; K!; P!; Z!).

This plant is known only from the type collection which differs from plants of typical *C. multiflora* by its oblanceolate leaves which are rarely longer than 2,5 cm.

31. **Crassula muscosa** L. var. **muscosa**

C. muscosa L., Pl. Rar. Afr. 10 (1760) et Mantissa altera 361 (1771); Harv., Fl. Cap. **2**: 351 (1862), partly, excl. specimens cited; Tölken in J. S. Afr. Bot. **38**: 70 (1972). Type: Cape, sine leg. in Herb. Burmann (G, holo!).

C. lycopodiodes Lam., Dict. 2: 173 (1786); Harv., Fl. Cap. **2**: 351 (1862); Schonl. in Trans. Roy. Soc. S. Afr. **17**: 189 (1929); Friedr. in Prodr. Fl. S. W. Afr. **52**: 31 (1968). Type: Africa, sine leg. in Herb. Lamarck (P–LA, holo!).

The different varieties of this species complex often grow in different ecological niches but equally often they are found next to one another.

C. polpodacea and *C. propinqua* which seem to refer to the var. *sinuata* and var. *rigida* respectively were not adopted, because their diagnoses are so vague and the original material is often confused so that the taxa concerned cannot be recognized without doubt. *C. parvula* is, however, easily interpreted.

1 Stems at base without old leaves and with peeling bark; leaves yellow-green and up to 0,1 cm long . . . . **C. muscosa** var. **rigida**
1 Stems with old leaves at the base; leaves grey-green 0,2–0,4 (–0,6) cm long:
  2 Squamae emarginate; stems wiry-woody with leaves adpressed 0,2–0,3 cm in diameter and up to 40 cm long . . . . **C. muscosa** var. **sinuata**
  2 Squamae truncate; stems woody or if wiry then with spreading leaves and erect habitat:
    3 Stems with leaves 0,3–0,4 (–0,6) cm in diameter; plants more or less branched and up to 60 cm long . . . . **C. muscosa** var. **muscosa**
    3 Stems with leaves c. 0,25 cm in diameter; plants erect tufts up to 15 cm high . . . . **C. muscosa** var. **parvula**

—— var. **parvula** (Eckl. & Zeyh.) Toelken, comb. nov. et stat. nov.
Tetraphyle parvula Eckl. & Zeyh., Enum. 294 (1837). Type: Cape, Botha's Berg, *Ecklon & Zeyher 1871* (S, lecto!).
Crassula parvula (Eckl. & Zeyh.) Endl. ex Walp., Repert. **2**: 253 (1843); Harv., Fl. Cap. **2**: 352 (1862).

—— var. **rigida** Toelken, var. nov. ab varietatibus aliis foliis usque ad 2 mm longis et obtusis, cortice cadenti membranaceo differt.
Plantae erectae 10–15 (–30) cm altae ramis principalibus ligneis et rigidis 0,2–0,5 (–0,8) cm in diametro sine foliis sed contice candenti membranaceo, ramis multis ad basim, ramis juvenibus foliis usque ad 0,3 mm in diametro et internodiis visilibus inter folia praecipue in exsiccata sed foliis veteribus deciduis. *Folia* ovata vel late ovata, 0,05–0,1 (–0,2) cm longa et lata, obtusa, apice effuso et gemma axillare in quoque axilla. *Squamae* truncatae.

Type: Cape, Stinkfontein, *Schlieben 11 530* (PRE, holo!; STE!).

Plants erect 10–16 (–30) cm high with rigid woody branches 0,2–0,5 cm thick without leaves and with peeling bark, branching mainly from the base and much branched, with younger branches with leaves up to 0,3 cm in diameter and with internodes visible between the leaves particularly in dried specimens, with old leaves deciduous. *Leaves* ovate to broadly ovate, 0,05–0,1 (–0,2) cm long and broad, obtuse, rarely more or less adpressed but with an axillary bud in the axil of all leaves, yellowish-green. *Squamae* truncate.

Occurs from the Cedarberg northwards through the mountains in Namaqualand and Richtersveld to just north of the Orange River.

—— var. **sinuata** Toelken, var. nov. ab varietatibus aliis ramis gracilibus sinuatis et squamis emarginatis.
Plantae ramis gracilibus sinuatis vel decumbentibus 30–50 (–80) cm longis, 0,2–0,3 (–0,4) cm in diametro foliis, minute ramosis et sine ramis axillaribus brevis, tenacibus et ligneis et internodiis non visibilibus inter folia adpressa, foliis veteribus non deciduis. *Folia* lanceolata 0,2–0,3 cm longa, 0,1–0,2 cm lata, acuta. *Squamae* emarginatae.

Type: Cape, near Komga, *Flanagan 1795* (BOL, holo!; GRA!; PRE!).

Plants with slender sinuous or decumbent branches 30–50 (–80) cm long, 0,2–0,3 (–0,4) cm in diameter with leaves, little branched and without short axillary branches, tough and woody and with internodes not visible between the leaves, with old leaves remaining attached to the stem. *Leaves* lanceolate 0,2–0,3 cm long, 0,1–0,2 cm broad, acute, yellowish-green rarely pale green. *Squamae* distinctly emarginate.

Occurs mainly in the triangle between Willowmore, Port Elizabeth and King William's Town.

32. **Crassula namaquensis** Schonl. & Bak.f. subsp. **comptonii** (Hutch. & Pillans) Toelken, comb. nov. et stat. nov.
C. comptonii Hutch. et Pillans, Botanist in S. Afr. 149 & illustr. (1946). Type: Cape, Vanrhyn's Pass, *Hutchinson 765* (K, holo!).

Within the species complex *C. namaquensis* the tendency for the rostrate petal apex to elongate from up to 1 mm in the subsp. *namaquensis* to 2 mm in subsp. *comptonii* and 2–3 mm in the subsp. *lutea* cannot be ignored. Similarly the petal colour changes from white or cream to pale yellow and bright yellow. The range of variation of the leaves found in the subsp. *namaquensis* covers the variation found in the whole species.

—— subsp. **lutea** (Schonl.) Toelken, comb. nov. et stat. nov.
C. namaquensis var. *lutea* Schonl. in Rec. Albany Mus. **1:** 117 (1904) et in Trans. Roy. Soc. S. Afr. **17:** 269 (1929). Type: Cape, Bokkeveld Karoo, *Marloth 3238* (GRA, holo!; K!).
C. lutea (Schonl.) Friedr. in Mitt. Bot. Staatssamml. **11:** 333 (1974).

33. **Crassula natans** Thunb. var. **filiformis** (Eckl. & Zeyh.) Toelken, comb. nov. et stat. nov.
Bullardia filiformis Eckl. & Zeyh., Enum. 290 (1837). Type: Cape, Platteklip, *Ecklon & Zeyher 1850* (GRA!; K!; S!; SAM!).
Helophytum natans (Thunb.) Eckl. & Zeyh. var *filiformis* (Eckl. & Zeyh.) Harv., Fl. Cap. **2:** 329 (1862), partly.
Crassula natans Thunb. forma filiformis (Eckl. & Zeyh.) Schonl. in Ann. Bolus Herb. **2:** 49 (1917).

The var. *filiformis* is much finer than the var. *natans* and the flowers are rarely up to 1 mm long and its petals do not recurve. The former grows usually on moist or marshy soil on the edge of the water, while the latter is often found in pools and under those conditions develops the typical broad floating leaves.

34. **Crassula nudicaulis** L. var. **herrei** (Friedr.) Toelken, comb. nov. et stat. nov.
C. herrei Friedr. in Mitt. Bot. Staatssamml. München **6:** 640, fig. 10 (1967). Type: Cape, Holgat River, *Herre* in SUG *8126* (M, holo!).

The typical var. *herrei* with almost terete leaves, as illustrated by Friedrich (1967) is an extreme form of a plant that has less fleshy leaves and marginal cilia near Komaggas. This form is, however, distinguished from plants of the typical variety on the Kamiesberg by its flowers in the globular part-inflorescences which are all directed upwards and not spreading in all directions.

—— var. **platyphylla** (Harv.) Toelken, comb. nov. et stat. nov.
C. platyphylla Harv. in Fl. Cap. **2:** 363 (1862). Type: South Africa, *Drège 6986* (S, holo!; G!).

The var. *platyphylla* is distinguished from the var. *nudicaulis* by its short broadly oblong leaves with subdistant marginal cilia and it has usually more than 24 ovules per carpel.

35. Crassula obovata Haw. var. **dregeana** (Harv.) Toelken, comb. nov. et stat. nov.
C. dregeana Harv., Fl. Cap. **2:** 346 (1862); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 223 (1929). Type: Natal, between Omsamculo and Omcomas, *Drège s.n.* (S, lecto!; BM!; G!; K!; LU!; P!; SAM!; TCD!).

The leaves of plants of this variety are almost terete and their recurved marginal cilia are adpressed so that they are indistinguishable from the other hairs that cover the leaves.

36. **Crassula pageae** Toelken, nom. nov.
Pagella archeri Schonl. in Ann. Bolus Herb. **3:** 67, t. 3A (1921); Berger in Pflanzenfam. ed. 2, **18a:** 400 (1930). Type: Cape, near Montagu Bath, *Page* in BOL *16 645* (GRA, holo!; BOL!; PRE!).

The genus *Pagella* was distinguished from *Crassula* by its fused carpels which are half sunk into the swollen stem, but a similar phenomenon, although less far-reaching, can be observed in for instance *C. hirsuta* and *C. glomerata. C. umbellata* and *C. dodii* which often grow together with *C. pageae* produce stunted forms where the internodes also do not elongate. *Pagella archeri* is thus included in the genus *Crassula* but the name cannot be transferred because of *C. archeri* Compton.

37. **Crassula pellucida** L. subsp. **pellucida**
C. pellucida L., Sp. Pl. ed. 1: 283 (1753); DC., Prodr. **3:** 386 (1828); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 193 (1929); Tölken in J. S. Afr. Bot. **38:** 71 (1972). Iconotype: Dillenius, Hort. Elth. t. 100, fig. 119.

The subspecies of this species complex are all geographically isolated except the subsp. *alsinoides* which occurs in forested areas, while the other subspecies are often found in the more open vegetation nearby.

1 Leaf sheath glabrous:
  2 Leaves ovate and abruptly constricted at the base and more or less fused to one another . . . . **C. pellucida** subsp. **marginalis**
  2 Leaves elliptic to elliptic-lanceolate with a cuneate to subpetiolate base:
    3 Receptacle and carpels remaining soft and membranous when fruiting; perennials with branches often longer than 20 cm long; south-western Cape as far north as the Winterhoekberge **C. pellucida** subsp. **pellucida**
    3 Receptacle and lower parts of carpels becoming tough and spongy when fruiting; annuals with branches rarely longer than 15 cm; mountains near Niewoudtville . . . . **C. pellucida** subsp. **spongiosa**
1 Leaf sheath more or less hairy:
  4 Internodes and pedicels glabrous; leaves abruptly constricted at the base and more or less fused to one another . . . . **C. pellucida** subsp. **marginalis**
  4 Internodes and pedicels hairy; leaves with cuneate base:
    5 Flowers single in the axil of leaves and mainly towards the apex of stems; leaf margin regularly denticulate . . . **C. pellucida** subsp. **alsinoides**
    5 Flowers in terminal clusters; leaf margin irregularly denticulate . . . **C. pellucida** subsp. **brachypetala**

—— subsp. **alsinoides** (Hook.f.) Toelken, comb. nov. et stat. nov.
Tillaea alsinoides Hook.f. in J. Linn. Soc. (Bot.) 7: 192 (1864). Syntypes: Fernando Po, *Mann s.n.* (K!); Abyssinia, near Ankobar, *Roth s.n.* (K!).
Crassula alsinoides (Hook.f.) Engl. in Abh. Preuss. Akad. Wiss. (1891) 231 (1892).

—— subsp. **brachypetala** (Drège ex Harv.) Toelken, comb. nov. et stat. nov.
C. brachypetala Drège ex Harv., Fl. Cap. **2:** 354 (1862); Drège, Zwei Pfl. Doc. 151 (1844), nom. nud. Type: Cape, between Umzimvubu & Umzimkaba Rivers, *Drège s.n.* (S, lecto!; G!; P!).
C. lineolata sensu Schonl. in Trans. Roy. Soc. S. Afr. **17:** 195 (1929).

—— subsp. **marginalis** (Dryand. in Ait.) Toelken, comb. nov. et stat. nov.
C. marginalis Dryand. in Ait., Hort. Kew ed. 1, **1:** 396 (1789); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 194 (1929). Type: Caput Bonae Spei, *Masson s.n.* (BM, holo!).

—— subsp. **spongiosa** Toelken, subsp. nov. ab subsp. *pellucida* sepalis et receptaculo spongiosentibus in fructu et florescentia praecoci differt.
Herbae annuae ramis glabris decumbentibus saepe nodis radicantibus. *Folia* elliptica et plerumque apicibus terminalibus incoloratis et cuneata ad basim; vaginae foliorum glabra vel 1–3 ciliis marginalibus. *Inflorescentia* cymus terminalis saepe ramosus vel fasciculatus et partim occulata foliis subtentis, pedicellis glabris. *Sepala* circiter petala aequantia, spongiosentia in fructu. *Carpella* basibus ovariis et receptaculo spongiosentibus in fructu.

Type: Cape, Uitkomst, *Barker 10 739* (NBG, holo!).

Annuals with decumbent glabrous stems often rooting at the nodes. *Leaves* elliptic and usually with colourless terminal apex and cuneate base; sheath glabrous or with 1–3 marginal cilia. *Inflorescence* a terminal cyme often slightly branched or densely clustered and partly hidden by the leaves subtending it, with glabrous pedicels. *Sepals* about as long as petals and becoming spongy after flowering. *Carpels* with lower parts of ovaries and the receptacle becoming spongy when mature.
CAPE—3119 (Calvinia): between Nieuwoudtville and Oorlogkloof (-AC), *van Breda 1406* (PRE); top of Vanrhyn's Pass (-AC), *Barker 9422* (NBG); Uitkomst (-AC), *Barker 10 739* (BOL).

38. **Crassula perfoliata** L. var. **perfoliata.** Toelken in J. S. Afr. Bot. **38:** 72 (1972).

As indicated earlier (Tölken, 1972) the varieties of this species complex overlap somewhat geographically except in the case of the var. *heterotricha* which has been found near plants of the var. *falcata*, but they have never been found at the same locality. However, the Transkei is botanically little known.

The var. *heterotricha* flowers in June and July while the var. *falcata* flowers like all the other varieties of this species during the period of December to March. The var. *falcata*, which has previously been combined with the var. *miniata* (Tölken, 1972), can be distinguished from that variety by its obtuse bracts in addition to its usually falcate leaves.

—— var. **falcata** (Wendl.) Toelken, comb. nov. et stat. nov.
C. falcata Wendl., Bot. Beobacht. 44 (1798); Willd., Enum. 341 (1809); Harv., Fl. Cap. **2:** 338 (1862); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 225 (1929). Type: Cape of Good Hope, *Wendland* in Herb. Willdenow *6277* (B, lecto!).

—— var. **heterotricha** (Schinz) Toelken, comb. nov. et stat. nov.
C. heterotricha Schinz in Bull. Herb. Boiss. ser. 1, **2:** 203 (1894). Type: Natal, Inschanga, *Rehmann 7892* (Z, lecto!).

39. **Crassula pubescens** Thunb. subsp. **radicans** (Haw.) Toelken, comb. nov. et stat. nov.
Globulea radicans Haw. in Phil. Mag. **66:** 27 (1827); Eckl. & Zeyh., Enum. 301 (1837). Type: Cape, near Grahamstown, *MacOwan 836* (GRA, neo!; SAM!).
Crassula radicans (Haw.) Dietr., Syn. Pl. **2:** 1031 (1840); Harv. Fl. Cap. **2:** 363 (1862); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 271 (1929).

The subsp. *radicans* is distinguished from the other two subspecies by its glabrous leaves and the frequent presence of adventitious roots on the lateral branches. The leaves of the subsp. *rattrayi* are denticulate and this subspecies is also distinguished from the subsp. *pubescens* by its almost spherical petal appendage which is about twice as long as broad in the latter subspecies.

—— subsp. **rattrayi** (Schonl. & Bak.f.) Toelken, comb. nov. et stat. nov.
C. rattrayi Schonl. & Bak.f. in J. Bot., Lond. **40:** 290 (1902); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 277 (1929). Type: Cape, Graaff Reinet, *Rattray 30* (GRA, holo!).

40. **Crassula rupestris** Thunb. subsp. **commutata** (Friedr.) Toelken, comb. nov. et stat. nov.
C. commutata Friedr. in Mitt. Bot. Staatssamml. München **6:** 623, fig. la-k (1967) et in Prodr. Fl. S. W. Afr. **52:** 26 (1968). Type: South West Africa, Kahanstal, *Merxmüller & Giess 3499* (M, holo).

The very narrow leaves usually distinguish the subsp. *commutata* from the typical subspecies while in plants of the subsp. *marierana* the pairs of leaves are fused more than half their length. The subsp. *commutata* is geographically isolated and the subsp. *marnierana* ecologically isolated from the typical subspecies which is the most widespread of them.

—— subsp. **marnierana** (Huber & Jacobsen) Toelken, comb. nov. et stat. nov.
C. marnierana Huber & Jacobsen in Cactus **31,** suppl. 8 (1952). Type: Cape, Touwsberg, *Esterhuysen 25 949* (BOL, neo!).

41. **Crassula sarcocaulis** Eckl. & Zeyh. subsp. **rupicola** Toelken, subsp. nov. ab subsp. *sarcocauli* foliis lineari-lanceolatis et subulatis, fere teretibus differt.
C. sarcocaulis sensu Schonl. in Trans. Roy. Soc. S. Afr. **17:** 214 (1929), non Eckl. & Zeyh.
Plantae erectae et expansae rare decumbentes, ramis principalibus carnosis 0,5–3 (–5) cm in diametro et cortice cadenti frustro. *Folia* lineari-lanceolata et subulata, 0,8–2 cm longa, usque ad 0,15 cm lata, plerumque fere teretia. *Sepala* 1,5–2 mm longa.

Type: Natal, Cathedral Peak Forest Reserve, *Killick 1371* (BOL, holo!; NH!; PRE!).

Plants erect and spreading rarely decumbent and much branched forming a dense shrub with carnose main branches 0,5–3 (–5) cm in diameter and with peeling bark (rarely somewhat flaking bark on young stems). *Leaves* linear lanceolate, broadest at the base, 0,8–2 cm long, up to 0,15 cm broad, usually almost terete. *Sepals* 1,5–2 mm long or about half as long as the petals.

A re-evalutation of the type specimen of *C. sarcocaulis* made it necessary to describe the subsp. *rupicola* for the taxon that is known under that species name.

This subspecies is widespread throughout the Drakensberg mountains and a second population of its occurs in the high mountains of the Mlanje district of Malawi.

42. **Crassula sarmentosa** Harv. var. **integrifolia** *Toelken*, var. nov. ab *sarmentosa* foliis semper petiolaribus et integris differt.
Folium petiolo 0,3–1,5 cm longo, lamina elliptica in omnes partes plantae, margine integre et hydathodis serialis secus marginem in pagina abaxiale. *Inflorescentia* floribus rectis et vix patentibus.

Type: Natal, Izotscha ravine, *Strey 7630* (NH, holo!; PRE!).

Leaves with a petiole 0,3–1,5 cm long, with lamina elliptic on the whole plant, with margin entire or almost so and with hydathodes in a single row on the margin on the undersurface. *Inflorescence* with flowers usually hardly spreading and erect.
NATAL—2930 (Pietermaritzburg): Inanda (-DB), *Wood 597* (SAM).
—2931 (Stanger): Umhloti rocks (-CA), *Wood 597* (NH).
—3030 (Port Shepstone): Ixopo (-AA), *Acocks 13 781* (PRE); Paddock (-CA), *Strey 5895* (NH, PRE); Izotscha Ravine (-CB), *Strey 7630* (NH, PRE).

43. **Crassula schimperi** Fischer & C. A. Mey. var. **schimperi**
C. schimperi Fischer & C. A. Mey., Ind. Sem. Petropol. **8:** 56 (1841). Type: Abyssinia, *Schimper 183* (ex hort. Petropol.) (K!).
Combesia schimperi (Fischer & C. A. Mey.) Schweinf., Beitr. Fl. Aethiop. 80 (1867).
Tillaea pentandra Royle ex Edgew. in Trans. Linn. Soc. **20:** 50 (1846); Britten in Fl. Trop. Afr. **2:** 384 (1871), partly. Type: India, Himalaya mountains, *Royle s.n.* (K, holo!).
Crassula pentandra (Royle ex Edgew.) Schonl. in Pflanzenfam. ed. 1, 3, **2a:** 37 (1890).
Sedum transvaalense Kuntze, Rev. Gen. 3, **2:** 85 (1898). Type: Transvaal, Johannesburg, *Kuntze s.n.* (NY, holo!).
Crassula transvaalensis (Kuntze) K. Schum. in Just's Jahresb. 26, **1:** 347 (1900); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 188 (1929); Friedr. in Prodr. F. S. W. Afr. **52:** 36 (1968).

The var. *lanceolata* is distinguished from the var. *schimperi* by the leaves which are all of equal length.

—— var. **lanceolata** (Eckl. & Zeyh.) Toelken, comb. nov. et stat. nov.
Tetraphyle lanceolata Eckl. & Zeyh., Enum. 294 (1837). Type: Cape, Krakakamma, *Ecklon & Zeyher 1874* (S!).

Crassula lanceolata (Eckl. & Zeyh.) Endl. ex Walp., Repert. **2:** 254 (1843).
Crassula filamentosa Schonl. in Ann. Bolus Herb. **2:** 63, plate 5, fig. 16 (1917) et in Trans. Roy. Soc. S. Afr. **17:** 188 (1929). Type: Cape, Majuba, *Hepburn 150* (GRA, holo!).

44. **Crassula sebaeoides** (Eckl. & Zeyh.) Toelken, comb. nov.
Grammanthes sebaeoides Eckl. & Zeyh., Enum. 303 (1837). Type: Cape, near Tulbagh, *Ecklon & Zeyher 1935* (K!; S!).
Grammanthes gentianoides (Lam.) DC. var. *sebaeoides* (Eckl. & Zeyh.) Harv., Fl. Cap. **2:** 331 (1862).
Dinacria sebaeoides (Eckl. & Zeyh.) Schonl. in Bull. Herb. Boiss. ser. 1, **5:** 859 (1897).

It was pointed out earlier under *C. grammanthoides* that the genus *Dinacria* cannot be separated from the genus *Crassula.*

45. **Crassula sediflora** (Eckl. & Zeyh.) Endl. ex Walp. var. **amatolica** (Schonl.) Toelken, comb. nov. et stat. nov.
C. amatolica Schonl. in Trans. Roy. Soc. S. Afr. **17:** 240 (1929). Type: Cape, Cata Ridge, *Dyer 356* (GRA, holo!; K!; LU!; PRE!).

The leaves of this variety are shorter (0,4–0,8 cm long) and broader (0,2–0,4 cm) and with a distinct row of marginal cilia.

46. **Crassula sericea** Schonl. var. **hottentotta** (Marl. & Schonl.) Toelken, comb. nov. et stat. nov.
C. hottentotta Marl. & Schonl. in Trans. Roy. Soc. S. Afr. **17:** 256 (1929); Friedr. in Prodr. Fl. S. W. Afr. **52:** 30 (1968). Type: Cape, Richtersveld, *Marloth 12 506* (GRA, holo!).

The distribution areas of the three varieties of *C. sericea* show some overlap. In both the var. *hottentotta* and the var. *velutina* some plants with intermediate characters to those of the var. *sericea* have been found and these plants were apparently not hybrids.

In their extreme forms the var. *hottentotta* is distinguished by its swollen recurved trichomes while the leaves of the other two varieties are covered with hairs. The var. *velutina* is distinguished by its acuminate petals.

—— var. **velutina** (Friedr.) Toelken, comb. nov. et stat. nov.
C. velutina Friedr. in Mitt. Bot. Staatssamml. München **6:** 653, fig. 8a–k (1967) et in Prodr. Fl. S. W. Afr. **52:** 36 (1968). Type: Cape, Numees, *Herre* in SUG *7978* (M, holo; PRE, iso!).

47. **Crassula setulosa** Harv. var. **deminuta** (Diels) Toelken, comb. nov. et stat. nov.
C. deminuta Diels in Bot. Jahrb. **39:** 467 (1907). Type: Transvaal, near Lydenburg, *Wilms 515* (B, holo†; E!; K!).

The var. *deminuta* has been recorded from only a few localities and one would need more field studies to evaluate the range of variation. This variety is distinguished from other varieties by its spike-like inflorescence and the abrupt change from the leaves to the much shorter bracts on the erect stem.

—— var. **longiciliata** Toelken, var. nov. ab varietatibus aliis ciliis marginalibus circiter 1,5 mm longis et squamis anguste oblongis differt.

Suffrutices perennes ramis ligneis usque ad 15 cm longis et foliis fasciculatis et amplectentibus circum ramos et rosulantibus in statu quieto. *Folia* elliptico-oblonga vel oblanceolata, 0,3–0,8 (–1) cm longa, 0,15–0,3 cm lata, obtusa, glabra sed ciliis marginalibus prominentibus et circiter 1,5 mm longa, dorso-ventraliter depressa et fere membranacea sed plerumque tenacia; vaginae foliorum 0,1–0,2 cm longa. *Inflorescentia* thyrsus floribus multibus. *Sepala* triangularia, glabra, acuta. *Petala* oblongo-oblanceolata, obtusa et appendicibus dorsalibus indistinctis, laevia. *Antherae* 0,3–0,5 mm longae, flavae. *Squamae* oblongo-cuneatae et plerumque breves 3plo longioribus. *Carpella* ovariis reniformibus stylis brevibus.

Type: Transvaal, Mount Anderson, *Galpin 13 622* (BOL, holo!; PRE!).

Perennials with woody branches up to 15 cm long, with leaves clustered and clasping around the stems and forming a rosette-like bud only in the resting period. *Leaves* elliptic-oblong to oblanceolate, 0,3–0,8 (–1) cm long, 0,15–0,3 cm broad, obtuse, glabrous but with prominent marginal cilia about 1,5 mm long, dorsiventrally flattened and almost membranous but usually tough, hardly spreading even on the erect stem; sheath 0,1–0,2 cm long. *Inflorescence* an almost flat-topped thyrse with many flowers. *Sepals* triangular, glabrous acute. *Petals* oblong-oblanceolate, with rounded apices and indistinct dorsal appendages, smooth. *Anthers* 0,3–0,5 mm long, yellow. *Squamae* oblong-cuneate and usually at least three times longer than broad. *Carpels* with reniform ovaries with short styles about a quarter the length of the ovaries.

Occurs mainly in the north-eastern Drakensberg but also in the mountains near Lydenburg.

TRANSVAAL—2530 (Lydenburg): Mount Anderson (-BA), *Galpin 13 622* (BOL, PRE).

NATAL—2828 (Bethlehem): Royal National Park (-DD), *Trauseld 201* (PRE); *Schelpe 1405* (NH).

—2829 (Harrismith): Injasuti (-AB), *Esterhuysen 20 261* (BOL); Cathedral Peak (-CC), *Killick 1487* (PRE).

LESOTHO—2828 (Bethlehem): Tsehlanyane valley (-BD), *Jacot Guillarmod 3981* (PRE); *4058* (PRE, RUH).

48. **Crassula southii** Schonl. subsp. **sphaerocephala** Toelken, subsp. nov. ab subsp. *southio* habitate decumbente et foliis angustis differt.

Suffrutices annui vel perennes ramis decumbentibus sinuosis et usque ad 15 cm longi. *Folia* anguste triangularis, 0,1–0,2 cm lata. *Squamae* quadratae vel transverse oblongae, 0,4 (–0,5) × 0,3–0,6 mm.

Type: Cape, Nquawakwe, *Bolus 8906* (BOL, holo!; GRA!).

Annuals or perennials with decumbent usually sinuous branches rarely longer than 15 cm. *Leaves* narrowly triangular, 0,1–0,2 cm broad. *Squamae* square to transversely oblong, 0,4 (–0,5) × 0,3–0,6 mm.

The subsp. *southii* occurs mainly along the lower Fish River, and the subsp. *sphaerocephala* has been recorded from near King William's Town to southern Natal.

NATAL—3030 (Port Shepstone): Izingolweni (-CA), *Ward 187* (PRE); Umtamvuma River (-CD), *Nicholson 1040* (NH, PRE).

CAPE—3127 (Lady Frere): Engcobo mountains (-DB), *Flanagan 2770* (PRE).

—3227 (Stutterheim): near Keiskammahoek (-CA), *Sim 1771* (PRE); *Story 3393* (PRE).

—3228 (Butterworth): Nquawakwe (-AA), *Bolus 8906* (BOL, GRA).

49. **Crassula subaphylla** (Eckl. & Zeyh.) Harv. var. **subaphylla**

Crassula subaphylla (Eckl. & Zeyh.) Harv. in Fl. Cap. **2:** 362 (1862); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 264 (1929). Type: Cape, near Gouritz River, *Ecklon & Zeyher 1916* (S!; SAM!).

Sphaeritis subaphylla Eckl. & Zeyh., Enum. 300 (1837); Dietr., Syn. Pl. **2:** 1034 (1840).

Sphaeritis incana Eckl. & Zeyh., Enum. 300 (1837). Type: Cape, between Beaufort and Graaff Reinet, *Ecklon & Zeyher 1917* (S!).

Crassula incana (Eckl. & Zeyh.) Harv. in Fl. Cap. **2:** 359 (1862); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 264 (1929).

C. incana is an extreme form of *C. subaphylla* and which is linked by a cline to plants from the eastern Cape. Although the two names were published at the same time, *C. subaphylla* is preferred, because it represents the more widespread taxon.

The var. *virgata* is more than a glabrous form of C. *subaphylla* as it usually occurs on hard gravelly slopes while the typical variety is found on sandy soils in depressions or along rivers. However, in contrast to the subspecies in the *C. tetragona* complex these two varieties are more tolerant and often grow next to one another.

—— var. **virgata** (Harv.) Toelken, comb. nov. et stat. nov.

C. virgata Harv., Fl. Cap. **2:** 360 (1862); Schonl. in Trans. Roy. Soc. S. Afr.

17: 264 (1929). Type: Cape, Pikenier's Kloof, *Zeyher 664* (S, lecto!; G!; K!; P!; SAM!).

50. **Crassula subulata** L. var. **fastigiata** (Schonl.) Toelken, comb. nov. et stat. nov.

C. fastigiata Schonl. in Trans. Roy. Soc. S. Afr. **17:** 261 (1929). Type: Cape,
b Melkhoutfontein, *Muir 3380* (GRA, holo!; PRE!).

The internodes are completely hairy in this variety which occurs on coastal dunes between Riversdale and Humansdorp.

—— var. **hispida** (Schonl. & Bak.f.) Toelken, comb, nov. et stat. nov.

C. hispida Schonl. & Bak.f. in J. Bot. **36:** 368 (1898); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 262 (1929), nom. illeg., non Haw. Type: Cape, Montague Bath, *Bolus 6704* (BOL, holo!; GRA!; K!; NBG!).

This variety with hairy leaves is only known from the type collection.

51. **Crassula tetragona** L. subsp. **tetragona**

C. tetragona L., Pl. ed. 1, 283 (1753); Sp. Pl. ed. 2: 404 (1762); Tölken in J. S. Afr. Bot. **38:** 78 (1972). Type: Caput Bonae Spei, sine leg. in LINN *400.6* (holo!).

The subspecies of this species complex often occur near to one another but remain in contrast to the varieties of *C. perfoliata* restricted to their own ecological niche.

1 Bracts without flowers on peduncle 2 or 3 pairs, if less than inflorescence irregularly branched or a flat-topped dichasium:
    2 Leaf sheath 0,05 (–0,1) cm long; stems decumbent, rooting . . . . **C. tetragona** subsp. **acutifolia**
    2 Leaf sheath (0,15–) 0,2 cm long; stems erect not rooting:
        3 Inflorescence with flowers densely clustered; plants with stems repeatedly branching . . . . **C. tetragona** subsp. **tetragona**
        3 Inflorescence loosely branched; plant with one main branch and rarely with lateral branches . . . . **C. tetragona** subsp. **rudis**
1 Bracts without flowers on peduncle 0, 1 pair; inflorescence a round-topped thyrse:
    4 Stems carnose with flaking bark, 0,3–1 (—1,5) cm in diameter . . . . **C. tetragona** subsp. **robusta**
    4 Stems woody with flaking bark, 0,2–0,4 (–0,6) cm in diameter . . . . **C. tetragona** subsp. **lignosa**
    4′ Stems carnose with peeling bark, 0,2–1,5 (–2) cm in diameter . . . . . . **C. tetragona** subsp. **connivens**

—— subsp. **acutifolia** (Lam.) Toelken, comb. nov. et stat. nov.

C. acutifolia Lam., Encycl. **2:** 175 (1783); DC., Pl. Hist. Succ. **1:** 2, t.2 (1799): Prodr. **3:** 384 (1828); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 208 (1929), partly. Type: Africa, sine leg. (P–LA, holo!).

—— subsp. **connivens** (Schonl.) Toelken, comb. nov. et stat. nov.

C. connivens Schonl. in Rec. Albany Mus. **2:** 141 (1907) et in Trans. Roy. Soc. S. Afr. **17:** 210 (1929). Type: Cape, Matjesfontein, *Purcell s.n.* (GRA, holo!).

—— subsp. **lignescens** Toelken, subsp. nov. ab subsp. *robusta* ramis lignescentibus usque ad 0,5 cm in diametro et foliis raro longioribus 2 cm; ab subsp. *conniventi* internodis levibus et cortice confringenti et caduco differt.
Plantae erectae vel saepe ramis flaccidus, usque ad 80 cm altos, ramis lignescentibus 0,2–0,5 cm in diametro ad basim et cortice confringenti et caduco. *Folia* 1,2–2 (—2,5) cm longa, 0,2–0,3 cm lata, plerumque mutica, expansa vel erecta in ramis juvenibus; folia veteria caduca; vaginae foliorum 0,05 (—0,1) cm longae. *Inflorescentia* thyrsiformis, plerumque ramis pluribus, ut videtur pileata, saepe pedunculo brevi et uno pari bractearum vel rare absenti, bracteolis numerosis. *Petala* c. 0,2 cm longa, dorsale porcata. *Squamae* paene quadratae sed leviter constrictae ad basim, plerumque integrae. *Carpellum* 6–8 ovulis.

Type: Cape, Eselsfontein Pass, *Tölken 3881* (BOL, holo!).

Plants erect and often somewhat scrambling amongst other shrubs, up to 80 cm high, with main branches woody, 0,2–0,5 cm in diameter at the base and with flaking bark. *Leaves* 1,2–2 (—2,5) cm long, 0,2–0,3 cm broad, bluntly rarely sharply acute, spreading or curved upwards on young branches, with old leaves deciduous, sheath 0,05 (—0,1) cm long. *Hydathodes* scattered over the rounded lateral sides and often extending onto the lower surface of the leaves. *Inflorescence* a round-topped thyrse, usually with many branches, often with indistinct peduncle with one or no pair of bracts without flowers in their axils but usually with numerous bracts on the dichasia. *Petals* c. 0,2 cm long, dorsally ridged. *Squamae* almost square but somewhat constricted towards the base, usually truncate. *Carpels* with (6—) 8 ovules.

This subspecies is locally common from near Montagu to Grahamstown and occurs sporadically in the mountains near Springbok and Vanrhynsdorp.

—— subsp. **robusta** (Toelken) Toelken, comb. nov. et stat. nov.
C. robusta Toelken in J. S. Afr. Bot. **38:** 79 (1972). Type: Cape, Pluto's Vale near Grahamstown, *Tölken 4281* (BOL, holo!).

—— subsp. **rudis** (Schonl. & Bak.f.) Toelken, comb. nov. et stat. nov.
C. rudis Schonl. & Bak. f. in J. Bot., Lond. **1:** 283 (1902); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 209 (1929). Type: Cape, Garies, *Alston s.n.* (GRA, holo!).

52. **Crassula thunbergiana** Schult. subsp. **minutiflora** (Schonl. & Bak.f.) Toelken, comb. nov. et stat. nov.
C. minutiflora Schonl. & Bak. f. in J. Bot., Lond. **40:** 288 (1902); Schonl. in Trans. Roy. Soc. S. Afr. **17:** 187 (1929); Friedr. in Prodr. Fl. S. W. Afr. **52:** 32 (1968). Type: Cape, Steinkopf, *Schlechter 11 496* (GRA, holo!; BM!; BOL!).

This subspecies is distinguished mainly by its somewhat elongated peduncles while the flowers of the typical variety become gradually smaller towards the north.

53. **Crassula tomentosa** Thunb. var. **interupta** (Harv.) Toelken, comb. nov. et stat. nov.
C. interupta Drège ex Harv., Fl. Cap. **2:** 361 (1862); Drège, Zwei Pfl. Doc. 90 (1844), nom. nud.; Schonl. in Trans. Roy. Soc. S. Afr. **17:** 267 (1929). Type: Cape, Silverfontein, *Drège s.n.* (S, lecto!; K!; P!).

This variety is distinguished from the typical one by the absence of a transition between the much longer basal leaves and the bracts on the erect stems. The squamae of the var. *interupta* are transversely oblong-cuneate.

54. **Crassula tuberella** Toelken sp. nov. ab *C. natanti* et *C. inani* rhizomate tuberellis et carpello ovulis sex differt.
Herbae ramis fastigiatis usque ad 15 cm altis et ramis paucis efferentibus rhizomate ramulis tuberellis terminalibus sphaericis usque ad 0,3 cm diametro. *Folia* linearis, 0,5–1,5 cm longa, 0,1–0,15 cm lata, obtusa, plus minusve plana supra, convexa subtus, erecta vel curva acropete, viridia; vaginae foliorum usque ad 0,1 cm longa, succulenta et adpressa. *Hydathodi* tres vel quattour seriales in marginem et una terminales. *Inflorescentia* 1 (—3) floribus axillaribus, pedicello erecto 3–6 mm longo et floribus tetrameris. *Sepala* anguste triangularia 0,8–1 mm longa, obtusa, succulenta, viridia. *Petala* ovata vel fere rhombica, 1,5–2 mm longa, obtusa et sine cristis dorsalibus, apicibus recurvis, alba. *Stamina* c. 1 mm longs, antheris atropurpuris et 0,1–0,2 mm longis, filamentis vix latescentibus ad basim et non connatis tubo petalorum. *Squamae* oblongo-cuneatae, 0,3–0,4 X 0,2–0,3 mm, truncatae, aliquantum constrictae ad basim, vix succulentae, albae vel roseae. *Carpella* ovariis paene obconicis, stylis brevissimis et stigmatibus ovarium glabrum ovulis sex fere sphericis et leviter papillosis.

Type: Natal, near Wakkerstroom, *Tölken 3117* (BOL, holo!).

Herbs with fastigiate erect branches up to 15 cm high, little branched and produced from an underground rhizome which has many small branches terminating in almost spherical tubers up to 0,3 cm in diameter. *Leaves* linear, 0,5–1,5 cm long, 0,1–0,15 cm broad, obtuse rarely bluntly acute, more or less flat on the upper surface, convex below, erect or often curved upwards from the middle, green; sheath up to 1 mm long, fleshy and adpressed. *Hydathodes* 3–4 in one row along the leaf margin and a terminal one below the apex. *Inflorescence* with 1 (—3) flowers in the axils of the leaves, with erect pedicels 3–6 mm long, with 4–merous flowers. *Sepals* narrowly triangular, 0,8–1 mm long, bluntly pointed, fleshy, green. *Petals* ovate to almost rhombic, 1,5–2 mm long, bluntly pointed and without dorsal ridges, recurved, white. *Stamens* about 1 mm long, with purple anthers 0,1–0,2 mm long, with filaments hardly broadened towards the base and not fused into a petal tube. *Squamae* oblong-cuneate, 0,3–0,4 × 0,2—0,3 mm, truncate, mainly constricted below the apex, slightly fleshy, white or pink.

Carpels with broad almost obconical ovaries and with very short styles from the inside margin of the ovaries and with terminal insignificant stigmas; ovary glabrous and with 6 ovules each almost spherical and densely covered with rows of faint papillae.

In marshy areas or shallow vleis at high altitude in the mountains between Wakkerstroom and Ermelo.

TRANSVAAL—2630 (Carolina): Lake Chrisse (-AC), *Moss 16 287* (J).

NATAL—2730 (Vreiheid): Naauwhoek (-AC), *Devenish 1005* (PRE); *Tölken 3117* (BOL).

LESOTHO—2829 (Bethlehem): Leribe (-CC), *Dieterlen 732* (NH).

Jl S. Afr. Bot. 41 (2): 125–130 (1975)

NOTES ON *ERICA* IN SOUTH AFRICA

H. A. Baker

Abstract

Five new species and one new variety of *Erica* from the south western Cape Province are described.

Uittreksel

AANTEKENINGE OOR *ERICA* IN SUID-AFRIKA
Vyf nuwe soorte en een nuwe variëteit van *Erica* van af die suid-westelike Kaapprovinsie word beskryf.

Erica toringbergensis H. A. Baker, sp. nov. (Ericaceae-Ericoideae) Ceramus. Frutex erectus, validus, c 1,3 m altus. *Rami* et ramuli erectiusculi, numerosi, tomentosi, ad maturitatem cicatricibus, foliorium delapsorium et glabri. *Folia* 3-nata vel irregularia, aggregata, 3–3,05 mm longa, incurva, imbricata, linearia vel anguste ovata, acutata, sulcata, glabra, juniores margine setosis, brevibus. *Flores* terminales, umbellati, aggregata corrolini; pedunculi 10 mm longi, glabri, atrorubri; bracteae remotae, lanceolateae, 2 mm longae. *Sepala* 4 mm longa ovatoacuminata, carinata, aliquantum effusa scariosa, glabra, intricata, similis corollae colorata. *Corolla* 8 mm longa tubularis, inflata, sicca, glabra, atrorosea; lobi 2 mm longi ovati, stellati, concolori sed brunnescens. *Filamenta* filiformia; antherae c 1 mm longae, inclusae, oblongae, laterales, brunneae, appendiculatae, poro fere 1/3 pars lobi; cristae ad basi latae, laceratae, arista terminali longa emittens, totum c 1 mm longum vel plus, album. Ovarium late oblongum, glabrum, stipitatum, stipite 2 mm longo; stylo incluso, stigmate capitellato.

Erect, robust shrub from a, possibly, fire-resistant rootstock, about 1,3 m high. *Branches* and branchlets numerous, erect-spreading, tomentose, the older scarred by the persistent leaf cushions, eventually glabrous. Leaves irregular, 3-nate to 6-nate, 3–3,5 mm long with petiole 1,5–2 mm long, incurved imbricate, linear to narrow-ovate or oblong, acute, sulcate, glabrous, the younger having short caducous setae on the margins, very crowded. Flowers terminal sometimes appearing axillary on very short brachlets, 3-nate to umbellate and very crowded, corolline; peduncles 10 mm long, glabrous, dark red; bracts three, median, lanceolate, 2 mm long. *Sepals* 4 mm long, ovate-acuminate, keeled,

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somewhat spreading, inbricate, glabrous, scarious, coloured as the corolla. *Corolla* 8 mm long tubular-inflated, dry, glabrous, pale to deep rose-pink; lobes 2 mm long, spreading, ovate, concolorous but turning brown. Filaments filiform; anthers included, lateral, oblong-obtuse, 1 mm long, smooth, light brown, appendiculate, pore c $\frac{1}{3}$ length of the cell; crests pendent with a broad, lacerate base terminated by a long awn-like basal appendage somewhat longer than the basal crest; the whole equal to or slightly longer than the cell, white. *Ovary* oblong, long stipitate, glabrous, the stipe 2 mm long; style included; stigma capitellate. Flowering season mid-summer and autumn.

Specimens Examined

CAPE—3321 (Ladismith): Below the rocky peak of Toringberg, north of Ladismith (-AD) alt. about 1 829 m, Jan. 1974 *G. Kirsten 460* (Holotype BOL; Isotypes, NBG, STE, PRE, K, BM). Also collected at Seven Weeks Poort, *Stokoe 6795* in 1938, and at type locality, 15.12.1956 *E. Esterhuysen 26767.* This taxon clearly belongs to the section *Ceramus* but differs from the few already described by, inter alia, its very unusually shaped anther appendages and its long, narrow, stipe. It appears to be distributed widely at high altitudes on the Klein Swartberg range.

Erica langebergensis H. A. Baker sp. nov. (Ericaceae—Ericoideae) Pyronium. Frutex erectus c 1 524 m altus. *Cauli et Rami* cicatibus foliorium delapsorum notari, ascendens, pubescens. *Folia* 3-nata, 1,5 mm longa, effusa vel ad maturitatem squarrosa, aliquantum incurva, sulcata, glabra, primo seto-ciliata, nudescens, linearia, subulata, vel lanceolata. *Flores* terminales, 3-nati, subcalycini; pedunculi c 1 mm longi, pubescens; bracteae remotae, foliaceae, coloratae, et unique saepe longiora. *Sepals* c 2 mm longa, ad apicem tubi corollae adscendens, ovatolanceolata, ad apicem carinatum, glabra breviter setosociliata, scariosa, rosea, ad apicem rubescens. *Corolla* c 3 mm longa, anguste cyathiformis, sicca, glabra, atrorosea; lobi erecti; anguste ovati. *Filamenta* graciles, sursum contracta; antherae manifestae, 0,7 mm longae anguste oblongae, cuneatae, subterminalis, muticae. *Ovarium* turbinatum, hispidum; stylo multum exserto; stigmate peltaticyathiformis.

Erect shrublet to about 45 cm. *Stem* and *branches* pubescent and with prominent leaf scars. *Leaves* 1,5 mm long, 3-nate, linear-subulate, spreading and at length squarrose, slightly incurved at maturity, sulcate, glabrous, setose-ciliate at first, becoming naked, mucronate. *Flowers* 3-nate, terminal, subcalycine; peduncles about 1 mm long, pubescent; bracts remote, leaf-like but coloured and one often longer. *Sepals* 2,0 mm long, reaching to the top of the corolla tube, ovate-lanceolate, keeled and sulcate-keel-tipped, glabrous, shortly setose-ciliate, scarious, becoming reddish at the apex. *Corolla* about 3 mm long, narrow-cyathiform, dry, glabrous, deepish rose pink; lobes 1,0 mm long, erect, narrow-ovate. *Filaments* slender, tapering upwards; anthers manifest, 0,7 mm long narrowly oblong-cuneate, sub-terminal, muticous. *Ovary* turbinate, hispid; style long-exerted; stigma peltate-cyathiform.

SPECIMENS EXAMINED

CAPE—3320 (Montagu) Leeurivierberg, Langeberg between Cogmans kloof and Swellendam on Southerly slopes, (-CC), alt. c 1 528 m, 28.10.1973 *E. Esterhuysen 33295* (Holotype, BOL).

This species has been placed in the section *Pyronium* where it seems rightly to belong. In that section its nearest relation appears to be *E. paniculata* L. but there are many differences in structure between them.

Erica omninoglabra H. A. Baker, sp. nov. (Ericaceae—Ericoideae) Ceramia. Planta gracilis, diffusa, ubi nonexposita faciens dense caespites, omnino glabra. *Rami* numerosis per graciles. *Folia* 3-nata, c 6 mm longa, effusa, recurva, non imbricata, linearia, acuta, dorsis rotundatis, plus minusve sulcata, ad apices aristatis. *Flora* plerumque terminales, umbellati, sed interdum subaxillares et solitarii in eadem planta, corollini; pedunculi 3,5 mm longi; bracteae remotae, 1 mm longae, foliaceae sed albae. *Sepala* c 1,5 mm longa, late ovata, premens, ad apices aristis, longis acuminatis, concava, scariosa. *Corolla* 3,25 mm longa, urceolata, similis sepalis tenue, faucem angustae, sicca, alba vel plus minusve dilute rosea, postremo brunnea; lobi erecti, subobtusae. *Filamenta* late ligulata, ad apices rosea; antherae inclusae, c 0,5 mm longae, ad basibus obtusae, laterales, muticae, poro fere pars dimidio lobi. *Ovarium* turbinatum sessilis; stylo exserto; stigmate simplici.

A slender, flexuous, straggling plant forming dense clumps when not exposed amongst rocks, completely glabrous. *Branches* very slender and intermixed. *Leaves* 3-nate, about 6 mm long, spreading and not imbricate, recurved, linear-acute, round-backed, variously sulcate, from faintly to deeply, tipped with a long arista. *Flowers* mostly terminal and umbellate, the umbels containing up to about 12 flowers and tightly packed, but sometimes sub-axillary on the same plant and then solitary in the leaf axils, corolline; peduncles 3,5 mm long; bracts median, 1 mm long, leaf-like but white. *Sepals* about 1,5 mm long, broad-ovate witha long, acuminate keel-tip or arista as have the leaves, thin in texture, scarious, concave, clasping the corolla. *Corolla* 3,25 mm long, urceolate, thin in texture, somewhat narrowed at the throat, white, tinged pink, becoming brown after maturity; lobes erect, somewhat crenate towards the apex, subobtuse. *Filaments* broad-ligulate, pinkish at the apex; anthers included, oblong, obtuse below, dorsically basifixed, muticous, about 0,5 mm long; pore about half the length of the cell; ovary turbinate, sessile; style long exerted; stigma simple.

SPECIMENS EXAMINED

CAPE—3320 (Montagu) Swellendam Mt. on slopes en route to Goedeloof Point (Misty Point), (–CD) alt. 1 380 m. October 1973 *Esterhuysen 33404* (Holotype, BOL).

This taxon would appear to be best placed in section *Ceramia* owing to its habit, but is not similar to any species therein described or in any other section.

Erica pillarkopensis H. A. Baker sp. nov. (Ericaceae—Ericoideae) Melastemon.

Fruticulus erectus, ligneus ad c 1 m altus. Rami numerosi pubescens, glabrescens. *Folia* 4–5 m longa, 3-nata, late linearia, effusa sed squarroscens, praeter jumiores vix vel non imbricata, varie sulcata, pubescens, ciliata pilis longiusculis, glandulosis. *Flores* pro parte maxima terminales ad apices ramulorum umbellati, sed interdum laterales et singulares in planta eadem, subcalycini, racemosi; pedunculi 4–5 mm longi, pubescentes, colorati; bracteae basales, parvulae, inconspicuae. *Sepala* 1–5 mm longa, adpressa, late ovata vel orbicularia, apicibus minute carinatis, pro parte maxima glabra sed ad marginem parce puberula, longa ciliata, scariosa, alba vel rosea. *Corolla* 3,0 mm longa, late obconica, sicca, glabra, atrorosea; lobi 1,0 mm longi, continui, vel leviter effusi, sepala similia formata sed oltusa et valde conspicua, saepe plus minusve alba et quam tubus dilutior. *Filamenta* ligulata, ad apicibus brunnea; antherae 1,0 mm longae, laterales, oblongae, cuneatae, supra porum productae, scabridae, minute aristis; artistae ad filamentum adnatum, spicibus libris, effusis. *Ovarium* turbinatum, glabrum, viride; stylo longo exerto; stigmate peltatocapitellato, parvo.

Erect, woody shrublet to about 1 m high. *Branches* numerous, pubescent, glabrescent. *Leaves* 3-nate, 4–5 mm long, broadly linear, spreading and becoming squarrose and, except the younger, barely or not imbricate, variously sulcate, pubescent, ciliate with longish gland-tipped hairs. *Flowers* essentially terminal at the ends of numerous branchlets but, sometimes, apparently axillary and solitary in the leaf axils on the same plant; the terminal ones umbellate, the whole making a compact and showy raceme, calycine; peduncles 4–5 mm long pubescent, coloured; bracts basal, very small and inconspicous. *Sepals* 1–5 mm long, adpressed, broad ovate to orbicular, minutely keel-tipped, mostly glabrous but with a few short hairs near the margins, long-ciliate, scarious, white to rose coloured. *Corolla* 3,0 mm long, broad obconical, dry, glabrous, dark rose; lobes 1,0 mm long, continuous, slightly spreading, shaped like the sepals and very conspicuous, often whitish and paler than the tube. *Filaments* ligulate, brown at the apex; anthers manifest 1,0 mm long, long, oblong cuneate, lateral, produced above the pore, scabrid, minutely awned; the awns adnate to the filament with small, free-spreading points. Ovary turbinate glabrous, green; style long-exserted; stigma peltate-capitate, small.

Specimens Examined

CAPE—3419 (Caledon): Pillarkop, Riviersondereinde Mts. (–BB) near Lindeshof on scree and steep rock slopes, alt. 1 220–1 524 m *Esterhuysen 33343* (Holotype, BOL).

This taxon does not correspond with any other described species. Owing to its distinctly produced anther cells above the pores it is placed in the section *Melastemon.*

Erica winteri H. A. Baker, sp. nov. (Ericaceae—Ericoideae) Pachysa.

Fruticulus erectus ad c. 50 cm altus, caulis singularis, pubescens. *Rami* sparsi, effusi, pubescens. *Folia* 3-nata, 3,5 mm longa, interdum irregulares, lanceolata, acuta, sulcata, glabra, primo imbricata, ad margines glandis parvis. *Flores* terminales, solitariae, corollini, pro parte maxima cernui; pedunculi 12 mm longi, glanduliferiviscidi; bracteae remotae, ovatae, ad sepalis similis sed parvis. *Sepala* 4 mm longa, adpressa vel effusa, ovata, diaphana, viscida, alba, glabra. *Corolla* 9 mm longa, globosourceolata, diaphana, valde viscida, glabra, alba, lobis erectis, 3 mm longis, latis, obtusis. *Filamenta* ligulata ad apices decressens; antherae 2 mm longae, inclusae, terminales, oblongae, lunatae, bipartitae, atrobrunnae, scabridae, poro fere pars dimidio lobi, appendiculatae; aristae 1 mm longae, subulatae, scabridae. *Ovarium* turbinatum, glabrum; stylo incluso; stigmate capitato.

Erect shrublet to about 50 cm high with a single, pubescent stem. *Branches*, sparse and laxly arranged, pubescent. *Leaves* 3-nate, somewhat irregular lanceolate, 3,5 mm long, erect-spreading, imbricate at first, acute, sulcate, glabrous, with small marginal glands. *Flowers* terminal on very short branchlets, solitary, corolline, mostly cernuous; peduncles 12 mm long, glandular-viscid; bracts remote, ovate, as sepals, but smaller. *Sepals* 4 mm long, adpressed to spreading, ovate, diaphanous, viscid, white. *Corolla* 9 mm long, globose-urceolate, diaphanous, viscid, white, glabrous; lobes erect, 3 mm long, wide, oblique. *Filaments* ligulate, narrowing slightly upwards; anthers included, 2 mm long, terminal, crescent-shaped, scabridulous, bipartite, dark brown, appendiculate; pore one half the length of the cell; awns 1 mm long, subulate, very rough; style included to just manifest; stigma capitate.

Specimens Examined

CAPE—3321 (Ladismith), Langeberg Mts., Riversdale (-CD) altitude c. 914 m, 7.10.1974 *J. H. S. Winter 20* (Holotype, NBG; Isotypes, STE, PRE).

This taxon has been collected several times before and determined as being a white form of *E. ardens* Andr. but, on close examination by the author, it is found to be only superficially like that species. A comparative table shows that there are many differences especially in the shape of the anthers and their appendages, the diaphanous sepals and corolla and the form of the plant which, in the case of *E. winteri* is laxly spreading, quite unlike *E. ardens*. Many of the collections in the herbaria have been found at flower shows in which case there is no proper record of the locality. When these differences are taken into consideration *E. winteri* would appear to be worthy of specific rank.

This species has been named in honour of Mr. J. H. S. Winter, the curator at the National Botanic Gardens, Kirstenbosch for the praiseworthy work he is doing there in growing ericas from seed and cuttings and planting them out in the ideal conditions that have been made for their growth in an environment, as natural as can be created in the Gardens.

Erica intervallaris Salisbury var. **trifolia** H. A. Baker var. nov.

A forma typica ita differt. *Rami* glabri. *Folia* 3-nata, linearia, subulata, 4 mm longa. Flores pro parte maxima 3-nata, interdum umbellata; pedunculi 3 mm longi. *Sepala* ovatolanceolata, apicibus carinatibus, ciliata, scariosa. *Corolla* tubularicampanulata, glabra, roseola. *Antherae* plus minusve similares sed aristae subcristastae, non gracilis.

As the type with the following differences: *Branches* glabrous. *Leaves* 3-nate, linear-subulate. *Flowers* mostly 3-nate but sometimes umbellate; peduncle 3 mm long. Sepals ovate-lanceolate, keel-tipped, ciliate, scarious. Corolla tubular-campanulate, glabrous, pale rose. Anthers more or less similar but the aristas subcristate, not slender.

SPECIMENS EXAMINED

CAPE—3418 (Simonstown): in wet places near the banks of the Palmiet River by the road bridge at low altitudes (-BD), 3.11.1964 *H. A. Baker 2190* (Holotype, BOL).

BOOK REVIEW

CYCADS OF SOUTH AFRICA, by Cynthia Giddy, with pp. 122, 32 colour plates and distribution maps. Cape Town, Purnell and Sons, 1974. R12,50.

This eminently readable book is indeed a valuable contribution to the growing number of popular books on indigenous South African plants. It is outstanding in its clear and intelligently devised sequence of chapters.

A world distribution map of the whole order and a brief account of the distribution of the three families are followed by some notes on the history of discoveries of *Encephalartos* in South Africa and an assessment of the present situation together with some thoughtful hints on their preservation for the future.

The chapter on general characteristics deals in unambiguous terminology with the stem, the roots, leaves, cones and the growth rate of the plants. This chapter is supplemented by a plate; morphology of cycads, showing in detailed drawings the characteristics of the whole plant, the leaf, leaflets, male and female cones.

The next chapter on reproduction gives a detailed account of pollination and fertilization, again supplemented by diagrams. Toxicity is briefly dealt with, but is followed by a comprehensive chapter on cultivation. It starts by a cleverly divided habitat analysis, listing the species according to their hardiness, then showing which characteristic leaf pattern falls into the various zones and finally bringing the rainfall pattern into the whole picture. Propagation, particularly by seeds, explaining the complex and time consuming maturing of the seeds is dealt with in great detail. Drawings of the seeds and seedlings at various stages of development support the written word. The various methods of vegetative propagation and methods of transplanting mature plants are also discussed in some detail. A short account of pests and diseases is followed by some hints about using cycads in landscaping and gardening.

With this chapter the general part of the book ends. The following chapter on varietal forms, hybrids and doubtful species leads into the special part of the book which starts off with a number of most helpful drawings, showing the median leaflets and seedling leaves of the various species in full size. Next comes the key to the species, using the leaflets as the main diagnostic character. An identification table at the end of the key lists all the critical characters of the species for easy comparison.

Two colour plates are devoted to the morphology of the cycads, damage and regrowth. And then detailed descriptions of all species follow, each of them supplemented by a distribution map and a full page colour plate consisting of 4–5 photos showing the plant in habitat and close ups of cones and leaves. A glossary of technical terms provides the uninitiated with that bit of extra information needed for the full understanding of the text.

Though the lavish colour photographs and Barbara Jeppe's skillful drawings certainly enhance the value of the book, it is this unpretentious, clear language and the consequent division of the text which makes it a good book, for which laymen and professionals alike can be grateful to the authoress.

WALTER WISURA

Jl S. Afr. Bot. 41 (3): 133–162 (1975)

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STUDIES IN THE GENUS *CASSIA* IN SOUTH AFRICA:

1. TAXONOMIC NOTES ON SPECIES OF THE SUB-GENUS *LASIORHEGMA*, SECTION *CHAMAECRISTA*

K. D. Gordon-Gray and D. P. K. Schorn
(*Bews Botanical Laboratories, University of Natal, Pietermaritzburg*)

Abstract

Seven species within *Cassia*, Subgenus *Lasiorhegma*, Section *Chamaecrista*, are recorded for the area covered by the *Flora of Southern Africa*, namely South West Africa, Lesotho,
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. A key

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ERRATUM

Vol. 41 (2): 93–124. New taxa and new combinations in the genus *Crassula*, by H. R. Tölken.

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For *Crassula perofliata* L. *var. perfoliata* read *Crassula perfoliata* L. var. *perfoliata.*

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opical
regions of the world. Within this widespread genus, Baker (1930) delimited three sub-genera, *Cathartocarpus* Pers. (*Fistula* DC.), *Senna* Benth. and *Lasiorhegma* Vogel. Within the last of these he recognized two sections, *Absus* Benth. and *Chamaecrista* Benth. The last section, *Chamaecrista* (Moench) DC. = [*Chamaecrista* Benth.] is represented in the sub-tropical regions of Asia, in Sri-Lanka (Ceylon) and in tropical and sub-tropical Africa. Because of the close relationships of its taxa, the section is difficult taxonomically.

Steyaert (1950), in revising its Asian and Tropical African representatives, and Brenan (1967), in his treatment of *Cassia* for the *Flora of Tropical East Africa*, laid a sound taxonomic foundation for the species of this Section, but did not deal with the Southern African plants. For South West Africa, Schreiber (1967) found only three of its species represented, namely *C. mimosoides* L., *C. biensis* (Steyaert) Mendonça & Torre, and *C. falcinella* Oliv. var. *parviflora* Steyaert.

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3536

STUDIES IN THE GENUS *CASSIA* IN SOUTH AFRICA:

1. TAXONOMIC NOTES ON SPECIES OF THE SUB-GENUS *LASIORHEGMA*, SECTION *CHAMAECRISTA*

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Abstract

Seven species within *Cassia*, Subgenus *Lasiorhegma*, Section *Chamaecrista*, are recorded for the area covered by the *Flora of Southern Africa*, namely South West Africa, Lesotho, Swaziland and South Africa. Three varieties are not maintained because each is considered as falling within the range of another established variety: one new variety is erected. A key permitting the identification of these species and their infraspecific variants is given.

Uittreksel

'n STUDIE VAN DIE GENUS *CASSIA* IN SUID-AFRIKA:
1. TAKSONOMIESE AANTEKENINGE OOR DIE SUB-GENUS *LASIORHEGMA* SEKSIE *CHAMAECRISTA*

Sewe spesies in die genus *Cassia*, Subgenus *Lasiorhegma*, Seksie *Chamaecrista* word aangedui in die gebied wat deur die *Flora van Suidelike Afrika* gedek word (Suidwes-Afrika, Lesotho, Swaziland en Suid-Afrika). Drie variëteite word weggedoen omdat daar gereken word dat hulle binne die perke van ander gevestigde variëteite val. Terselfdertyd word een nuwe variëteit geskep. 'n Sleutel vir die identifikasie van die onderskeie spesies en hulle naverwante variëteite word aangegee.

The distribution of *Cassia* L. is throughout the tropical and sub-tropical regions of the world. Within this widespread genus, Baker (1930) delimited three sub-genera, *Cathartocarpus* Pers. (*Fistula* DC.), *Senna* Benth. and *Lasiorhegma* Vogel. Within the last of these he recognized two sections, *Absus* Benth. and *Chamaecrista* Benth. The last section, *Chamaecrista* (Moench) DC. = [*Chamaecrista* Benth.] is represented in the sub-tropical regions of Asia, in Sri-Lanka (Ceylon) and in tropical and sub-tropical Africa. Because of the close relationships of its taxa, the section is difficult taxonomically.

Steyaert (1950), in revising its Asian and Tropical African representatives, and Brenan (1967), in his treatment of *Cassia* for the *Flora of Tropical East Africa*, laid a sound taxonomic foundation for the species of this Section, but did not deal with the Southern African plants. For South West Africa, Schreiber (1967) found only three of its species represented, namely *C. mimosoides* L., *C. biensis* (Steyaert) Mendonça & Torre, and *C. falcinella* Oliv. var. *parviflora* Steyaert.

Accepted for publication 24th January, 1975.

For South Africa, Harvey (1862) recognized only *C. mimosoides* with varieties *capensis* Thunb., *stricta* E. Mey. and *comosa* E. Mey. Forbes (1922), in revising the Natal species of the genus, followed Harvey, as have other workers concerned with the preparation of provincial or local floras or check lists, an exception to this being the recent publication by Ross (1972).

In undertaking taxonomic revision of *Cassia* for the *Flora of Southern Africa*, and bearing in mind comments by previous workers within the Section *Chamaecrista*, such as those of Harvey (1862: 273) who wrote of *C. mimosoides*,

> "A common tropical and sub-tropical weed, which has received at least a score of names in different countries. . . . I find it impossible strictly to limit the variation, and all the South African varieties inhabit the same districts, and probably often grow intermixed."

and Brenan (1967),

> ". . . the species . . . belonging to the Section Chamaecrista . . . are critical and often closely related and taxonomically extremely difficult. Many of them are imperfectly known and often with very little material available for study . . . . Those who have studied carefully these critical Cassias in the living condition agree about their distinctness, but not infrequently it happens that the species appear easier to separate when alive than in the herbarium."

it was obvious that special attention would have to be given to study of plants of this section in herbaria, in the field and probably under cultivation, before the main work of revision was commenced. This was done. The paper that follows presents notes relevant to the taxonomic treatment of species of this section that cannot conveniently be included in the main revision of the genus which will be published elsewhere.

1. **Cassia comosa** (E. Mey.) Vogel, Syn. Gen. Cassiae: 65 (1837); Ghesq. in Bull. Jard. bot. Etat Brux. **9:** 153 (1932); Steyaert in Bull. Jard. bot. Etat Brux. **20:** 251 (1950); Brenan in F.T.E.A. Leg. (Caesal.): 89 (1967). Type: South Africa, E. Cape Province, between Umzimvubu R. [Omsamwubo] and Umsikaba R. [Omsamcaba], *Drège* (? B. holo.).

C. mimosoides L. var. *comosa*, Harv. in Fl. Cap. **2:** 273 (1862).

Chamaecrista comosa E. Mey., Comm. Pl. Afr. Austr.: 160 (1836).

This tropical and southern eastern African perennial is probably the most easily recognized of the South African species falling within the Section *Chamaecrista:* its large sessile petiolar gland (Fig. 1 B1, B2), leaf rhachis with adaxial

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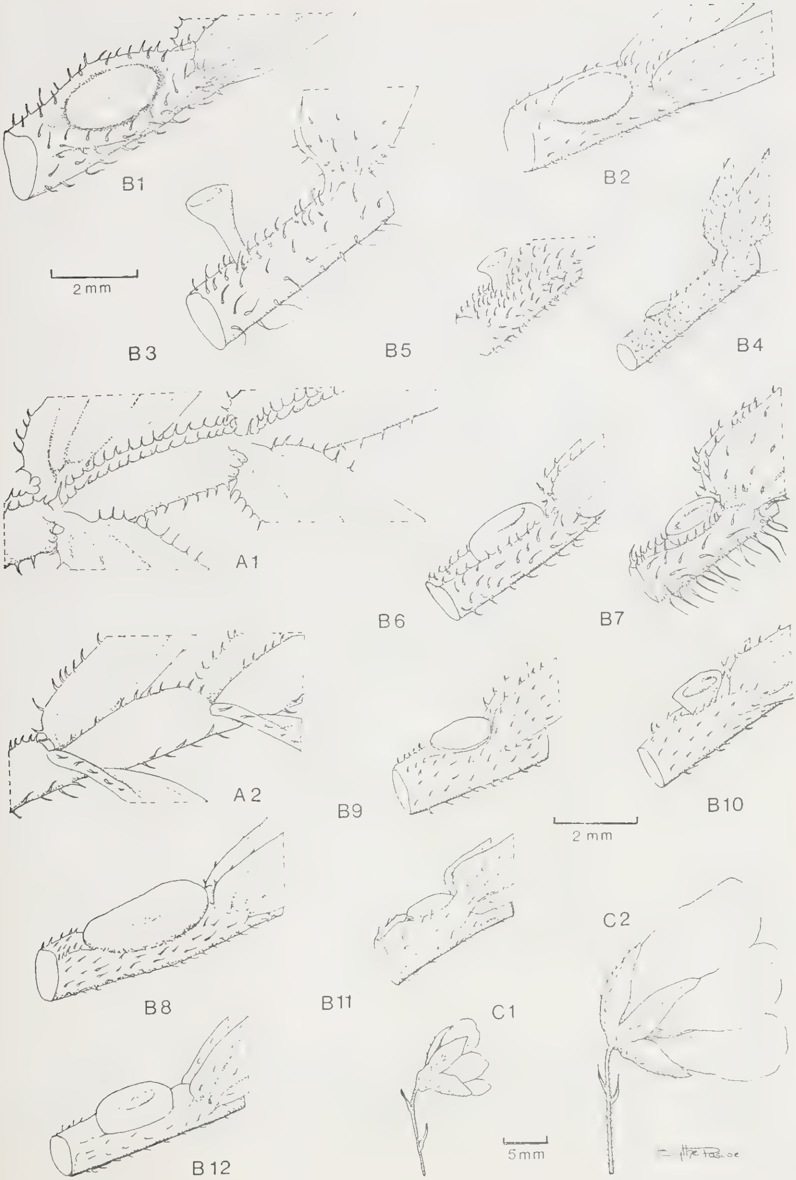
Fig. 1.

Features used in the preliminary rapid identification of species within the Section *Chamaecrista* in southern Africa (excluding Rhodesia and Moçambique): A—Adaxial surface of leaf rhachis: 1—channelled (*C. quarrei* illustrated), 2—crested (*C. plumosa* illustrated): B—Petiolar gland: 1—*C. comosa* var. *comosa*, 2—*C. comosa* var. *capricornia*, 3—*C. capensis* segregant glandulastipitata, 4—*C. capensis* var. *capensis* (also many specimens of var. *flavescens*), 5—*C. biensis*, 6—*C. quarrei*, 7—*C. falcinella* var. *parviflora*, 8—*C. mimosoides* segregant natalensis, 9—*C. mimosoides* segregant zululandensis, 10 & 11—*C. mimosoides* segregant okavangoensis, showing variation from slightly stalked to sessile, 12—*C. plumosa:* C—Flowers, to show variation in size: 1—*C. biensis*, 2—*C. capensis.*


B1
B2
2 mm
B3
B5
B4
A1
B6
B7
A2
B9
B10
2 mm
B8
B11
C2
C1
B12
5 mm

channel, wide leaflets (Fig. 2f, g) and large flowers are distinctive. Steyaert (1950) established two varieties within it: var. *lanata* which differed from typical *C. comosa* in its lanate pubescence covering almost all parts of the plant, and its smaller leaves and leaflets, and var. *capricornia* that was smaller in all its parts, but undoubtedly related by the similarity in form of the petiolar gland.

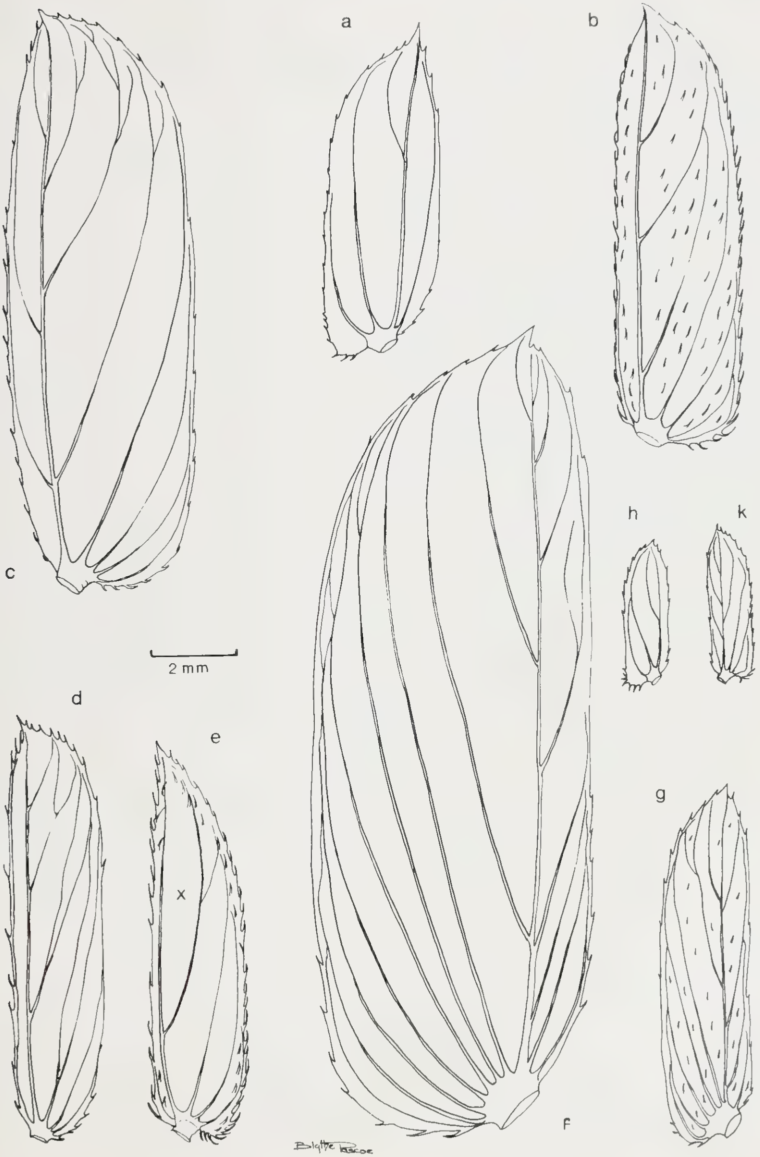
In our opinion "lanate" (woolly) is not accurately descriptive of the indumenum represented on the type of var. *lanata* (Natal, Mtunzini, Myezaan Zulu Reserve, near Nyoni, *Wood 3855*, K, holo; NH, iso!), since the hairs are not matted. "Velutinous" (velvety) seems a better term to apply, and this will be used where relevant, in the account that follows.

The type of the species (var. *comosa*) comes from the southernmost limit of the known distributional range. Here plants are often glabrous or glabrate, with large leaves and leaflets. Some decrease in the size of these organs seems to occur northwards and away from the coast, so that some plants from Richard's Bay, False Bay, Ngoye and Eshowe are not so robust. Study of populations in the field suggests this variation may be more closely linked with differences in microhabitat than with gradients in latitude and altitude, however. Steyaert's type of var. *lanata* is one of these slightly smaller leaved plants, but a velutinous pubescence is not correlated with smaller leaf size. Within the same population plants may vary slightly in leaf and leaflet size and in density of indumentum. There is usually, also, a falling off in the hairiness of a plant with increasing age. Because of this variation within a population, and because within var. *capricornia* also (see later) a wide range in density of the indumentum, especially of stems, occurs, var. *lanata* is not maintained but is included within var. *comosa*.

Steyaert (1950: 252) recorded typical *C. comosa* for Natal only, and var. *lanata* for Natal and Malawi (Nyasaland). From the distributional information given by Brenan (1967: 89), it must be implied that var. *comosa* is in Malawi and Moçambique, but it is not clear whether it is present with var. *capricornia* in the Congo Republic and Tanzania (Tanganyika). His description of the species includes "stems . . . densely spreading hairy", but he does not mention var. *lanata* as such. Existing records suggest var. *comosa* (including var. *lanata*?) is present on the coastbelt of Moçambique, but its presence in Rhodesia and Zambia requires confirmation.

FIG. 2.

Leaflet structure (each leaflet removed from midway along leaf rhachis): a—*C. quarrei*, b—*C. falcinella* var. *parviflora*, c—*C. capensis* segregant glandula-stipitata, d—*C. capensis* var. *capensis*, e—*C. biensis* (the areola marked X usually characterizes the leaflets of this species), f—*C. comosa* var. *comosa*, g—*C. comosa* var. *capricornia*, h—*C. plumosa*, k—*C. mimosoides*.


a
b
c
2 mm
d
e
x
f
h
k
g
Blythe Pascoe

Steyaert named var. *capricornia* for its distribution in relation to the Tropic of Capricorn "La distribution de cette variété à cheval sur le tropique du capricorne lui vaut son nom.", but South African records show its presence in Swaziland and the Transvaal, northwards from 27°S. It is not known from Natal (Fig. 4). The two varieties have different habitat requirements. Var. *comosa* is restricted to open grassland with a high water table on sand or granite soils. All known records are from near the coast, Ngoye Forest and Hlinza Forest near Eshowe being the furthest inland. In 1911 Rudatis found plants at Dumisa, a little inland from Umzinto. Now-a-days a distributional disjunction seems to exist on the coastbelt of Natal between the Port Shepstone and Mtunzini districts: it is tempting to attribute this to the destruction by man of suitable habitats in his cultivation of the land. Var. *capricornia*, in contrast, occurs in drier areas, usually in grassland or among boulders, often on sandy or gravelly soils, frequently where there has been some disturbance of the primary vegetation: occasionally plants colonize old lands. The Swaziland and Transvaal plants are not uniform in indumentum but show the same range in density of hairs, particularly on stems, that is represented within var. *comosa*, with var. *lanata* included within it.

Thus, according to known records, the varieties *comosa* and *capricornia* are allopatric in South Africa. This pattern of distribution, together with their minor morphological differences and distinct habitat preferences, suggests subspecific ranking would more correctly reflect, taxonomically, the natural variability within *C. comosa* in South Africa than does the present infraspecific treatment. But not all workers agree upon the need for geographic discontinuity in the definition of subspecies. Nor are the distribution patterns further north fully known.

Steyaert (1950) described *C. parva* which, according to Brenan (1967: 89) is one of the least well defined species of the Section. He says of it, "the material is not homogenous and seems to comprise a series of forms intermediate between and to some extent linking up *C. comosa* on the one hand and *C. katangensis* on the other." Differences in size and shape of the petiolar gland and its degree of projection above the petiole, as well as slightly narrower leaflets (1,25–3,0 mm in *C. parva*; 1,4–3,0 mm in *C. comosa* var *capricornia*), distinguish *C. parva* from *C. comosa* var. *capricornia*. Steyaert (1952) in his key separated them on petiolar gland colour alone (black in the former, yellow in the latter). No specimens agreeing precisely with the type of *C. parva* have been seen from S. Africa in the present study. However the closeness of the relationships of these taxa and the non-homogeneity of *C. parva* make further study of these species desirable. This will be done to best advantage in the Flora Zambesiaca area, which zone forms a link between Tropical East and South Africa, and where the taxa in question have not yet been fully documented.

Selected Citations

var. *comosa*

NATAL—2831 (Nkandla): Eshowe distr., Eshowe swamps (-CD), *Gerstner s.n.* (PRE, NH).

—2832 (Mtubatuba): Hlabisa distr., w. of St. Lucia Estuary (-AD), *Feely & Ward 5* (PRE, NH, NU).

CAPE—3129 (Port St Johns): Transkei, Lusikisiki distr., Magwa Falls (-BC), *Davies s.n.* (NU).

var. *capricornia*

TRANSVAAL—2430 (Pilgrim's Rest): Pilgrim's Rest distr., Blyde R. Nature Reserve (-BD), *Burtt & Hilliard 6029* (PRE, NU).

SWAZILAND—2631 (Mbabane): Mbabane distr., Mbabane (-AC), *Burtt Davy 2761* (PRE).

2. **Cassia capensis** Thunb. Prod. Pl. Cap. **1:** 79 (1794); Lodd. in Bot. Cab. **VI:** 511 (1821); Thunb. in Fl. Cap. **1:** 388 (1823); Vogel in Syn. Gen. Cassiae: 64 (1837); Steyaert in Bull. Jard. bot. Etat Brux. **20:** 250 (1950). Type: South Africa, Cape Province, between Loerie (?) [Luri] and Sundays R. [Sontags] *Thunb. s.n.* (UP, holo).

C. mimosoides L. var. *capensis* Harv. in Fl. Cap. **2:** 273 (1862).

Chamaecrista capensis (Thunb.) E. Mey. in Linnaea, **7:** 172 (1832) et in Comm. Pl. Afr. Austr. 1: 158 (1836).

C. capensis is another perennial species within the Section that is fairly easily recognized. Steyaert (1950: 250) remarked that it is probably the only species of *Chamaecrista* in which the inflorescences are really axillary. This, together with the large flowers (Fig. 1 C2), the long pedicels, which are evident at the fruiting stage also (nothing of the same magnitude has been recorded for tropical species), and the strongly excentric midrib to each leaflet (Fig. 2c, d), serve to distinguish *C. capensis*. Its distribution is also more temperate than that of its relatives (Fig. 5).

Morphologically it is not homogenous and infraspecific categories have been recognized within it. Meyer (1836) established within *Chamaecrista capensis*, var. *flavescens* (Type: South Africa, Cape Province, between the Gekau and Bashee Rs. [Basche], alt. 1 500–2 000 ped., *Drège*, B, holo.) for plants that differed from Thunberg's type in being more robust with patently hairy stems: on the lateral branches these spreading hairs were yellow. The leaves were longer with the petiolar glands often obsolete. Vogel (1837) maintained this variety under *Cassia capensis*. Steyaert (1950) described var. *keiensis* (Type: South Africa, Cape Province, King William's Town distr., Kei Road, *Dyer 1703*, K,

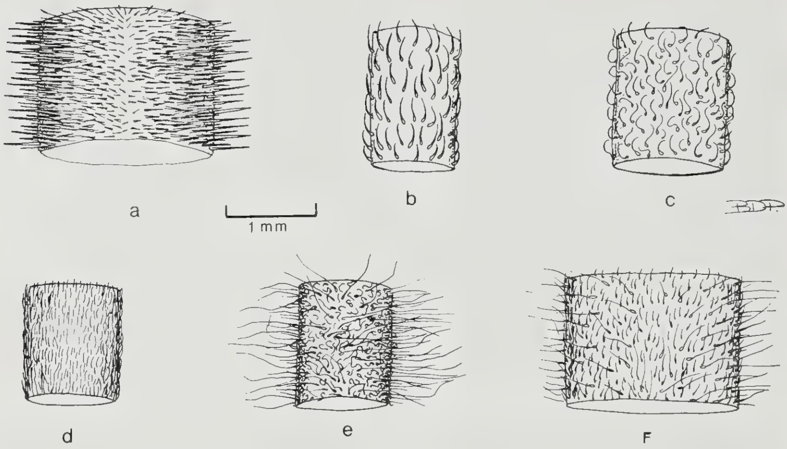


Fig. 3.
Stem pubescence: a—*C. plumosa* var. *erecta* (*Hilliard* 3883), b—*C. plumosa* var. *plumosa* (*Ward* 1873), c—*C. biensis* (*Maguire* 2212), d—*C. capensis* var. *capensis* (*Long* 889), e—*C. capensis* var. *keiensis* (*Dyer* 1703 isotype), f—*C. capensis* var. *flavescens* (*Flanagan* 54).

holo.: PRE, GRA, iso!) for plants that were covered by a more or less silky indumentum except on the petals and parts of the leaves [1]

Study of the species in field and herbarium has revealed the variability in growth form, robustness of stems and leaves, density and composition of indumentum (Fig 3d, e, f), degree of channelling of the adaxial surface of the leaf rhachis, and the number and extent of development of the petiolar glands (Fig. 1 B4) that occur in different plants. These characters are not necessarily correlated, so that a range of morphological form is represented. Some specimens differ from typical *C. capensis* only in the presence of many patent long hairs among the shorter hairs of the indumentum. These shaggy hairs impart a velutinous appearance to the stems that is visible to the naked eye: often these hairs are fulvus or yellowish, so that the younger parts of the plant, where the hairs are closely-packed, appear sericeus, fulvus or bright yellow. Steyaert's var. *keiensis* was established for sericeusly hairy specimens.

Sometimes these characters are correlated, and some plants, especially well represented from East London northwards to Port Shepstone, are robust, erectly growing sub-shrubs or sub-suffrutices with larger leaves, poorly defined channelling to the adaxial surface of the leaf rhachis, two, one, a rudimentary, or no petiolar gland, and a fulvus or bright yellow velutinous indumentum. Meyer's var. *flavescens* was established for such robust, velutinous specimens. Not all robust plants develop long straight patent hairs, however. Some lack these hairs entirely and are either glabrate or glabrous to the naked eye.

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[1] Steyaert, 1950: 251 records the locality for *Dyer 1703*, K, as Kingwilliamstown distr., Kei Road, but isotypes in PRE: GRA both carry the locality "near Debe Nek", Middeldrift distr.).

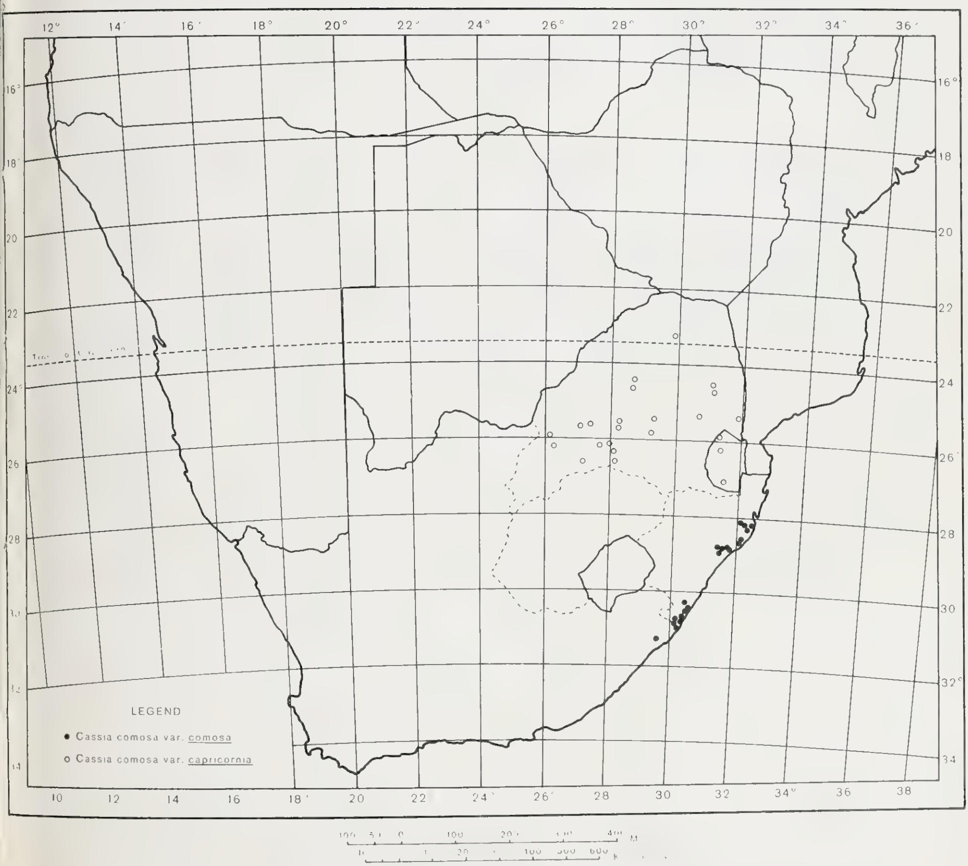


FIG. 4.
Cassia comosa—known distribution in southern Africa (excluding Rhodesia and Moçambique) up to 1974.

With such variability, effective infraspecific classification becomes difficult. It is considered unnecessary to maintain Steyaert's variety, for it represents only part of the range of variability already recorded. It is, therefore, included within var. *flavescens*, in which taxon are included all robust plants whether they be velutinous or glabrous.

Plants falling within var. *flavescens* are not confined to the eastern Cape. They have been recorded from as far north and inland as Kranskop in Natal, Swaziland and the south and central Transvaal. Most of these outliers resemble the type of Steyaert's var. *keiensis* rather than the very robust, erectly growing plants that are so well represented in the Transkei and southern Natal.

Var. *capensis* is also found in the Transvaal, but its main area of distribution is in the Cape from Cathcart and Kingwilliamstown southwards to Humansdorp. A single gathering (*White 480*, PRE) from Kleinmonde [Kleinmond]? suggests this variety may extend almost to the Cape Peninsula, but this needs confirmation that was not obtained during the present study. Steyaert 1950:250 cited M.M. *Stewart 110*, K from Hlatikulu, Swaziland as var. *capensis* but this is better placed with var. *flavescens* and corresponds with recent gatherings from this country by Compton. The distributional limits of the species are not adequately known. Attempts to locate it in Zululand, the northern Transvaal, Moçambique and Rhodesia are needed.

A further variant, presently known by only few specimens from disjunct localities (the Hluhluwe district of Natal, the Pietersburg district of the Transvaal and an unspecified locality in Moçambique) must tentatively be placed with *C. capensis*. The long axillary pedicels and the strongly excentric midrib to the leaflet suggest this relationship. There is similarity also in the small size and fewer pinna pairs of the leaves developed low on the stems. The clearly stalked petiolar gland (stalk 1,0–1,5 mm long) (Fig. 1 B3) and the flowers that are smaller than usual for *C. capensis*, yet larger than those of many other species of *Chamaecrista*, make this segregant distinctive. The stipitate petiolar gland suggests relationship with other more tropically distributed taxa, *C. zambesica* Oliv., *C. fallacina* Chiov. and others, but the relationship with *C. capensis* is much more clearly marked. At present it is considered unwise to establish an infraspecific taxon for what may prove to be an occasional genetic segregant (perhaps unlikely in view of Ward's *two* gatherings from *two* localities in the Hluhluwe district). Consequently such plants are temporarily identified as *C. capensis* segregant glandula-stipitata. The term "segregant" is used rather than "variant" to avoid any confusion with "variety" and the abbreviation to "var.".

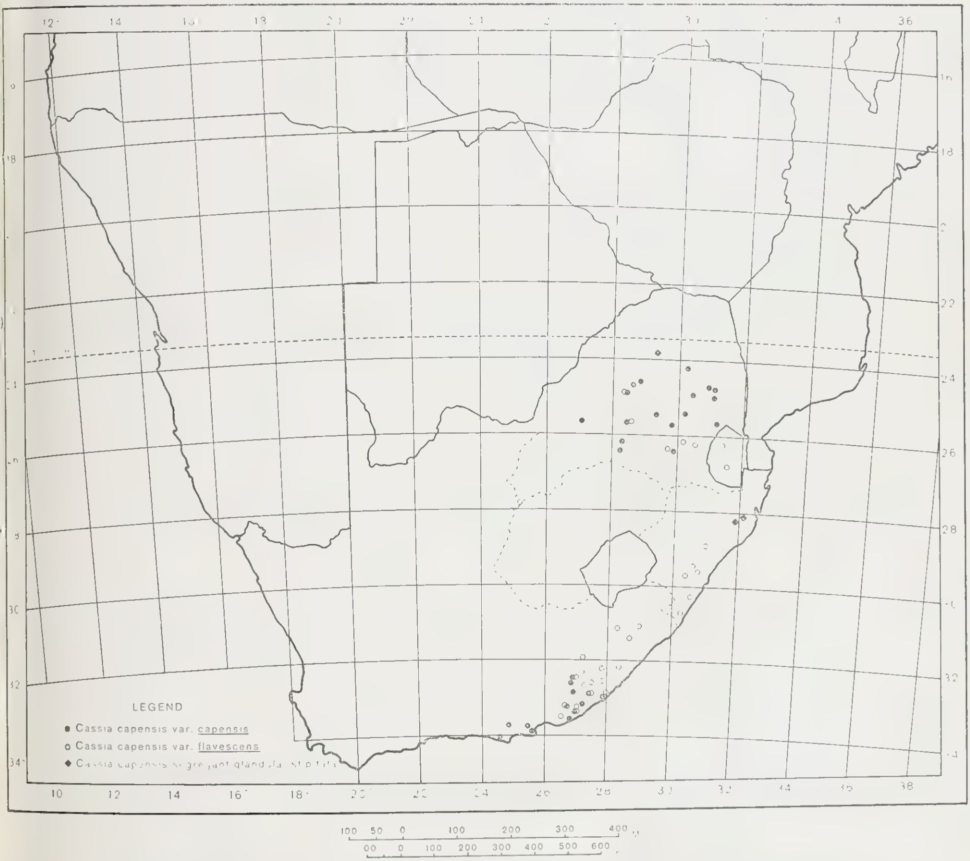
SELECTED CITATIONS

var. *capensis*

TRANSVAAL—2428: Waterberg distr., Nylstroom (-CB), *de Jongh s.n.* (Galpin Herb. *6478* GRA).

—2527 (Rustenburg): Rustenburg distr., Rustenburg (-CA), *Lanham 24* (PRE).

—2628 (Johannesburg): Kempton Park distr., between Johannesburg & Irene (-AB), *Hutchinson 2609* (PRE).


LEGEND
● Cassia capensis var. capensis
○ Cassia capensis var. flavescens
◆ Cassia capensis segregant glandular stipitate
10
12
14
16
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34
100 50 0 100 200 300 400
100 0 100 200 300 400 500 600

FIG. 5.

Cassia capensis—known distribution in southern Africa (excluding Rhodesia and Moçambique) up to 1974.

—2629 (Bethal) Ermelo distr., Athole Pasture Research Station (-DB), *Preller 145* (PRE).

CAPE—3324 (Steytlerville): Hankey distr., Van Stadenshoogte (-DD), *MacOwan 2051* (GRA).

—3325 (Port Elizabeth): Kragga Kamma, *Long 889* (PRE, GRA, RU).

var. *flavescens*

TRANSVAAL—2428 (Nylstroom): Warmbad distr., Warmbaths (-CD), *Leendertz 5546* (PRE).

—2630 (Carolina): Carolina distr., Carolina (-AA), *Rademacher 99* (PRE).

SWAZILAND—2631 (Mbabane): Mbabane distr., Hawane Falls (-AC). *Compton 27405* (NBG); Black Umbuluzi Valley (-AC), *Karsten s.n.* (NBG); Hlatikulu distr., Hlatikulu (-CD), *Stewart 110* (NBG, K).

NATAL—2830 (Dundee): Kranskop distr., Kranskop (-DD), *Thode 4032* (STE).

—2930 (Pietermaritzburg): Camperdown distr., Key Ridge (-DA), *Gordon-Gray 6145* (NU).

—3030 (Port Shepstone): Port Shepstone distr., cliffs above Otterburn Halt (-CD), *Hilliard 2751* (NU).

CAPE—3128 (Umtata): Transkei, Umtata distr., slope towards Umtata waterfall (-DB), *Schonland 3804* (PRE, GRA).

—3227 (Stutterheim): East London distr., 16 km. from East London on Kingwilliamstown rd. (-DD), *Comins 995* (GRA).

segregant glandula-stipitata

TRANSVAAL—2428 (Nylstroom): Pietersburg distr., 11 km. e. of Magalakwin Causeway (-BB), *Mogg 24430* (PRE).

NATAL—2832 (Mtubatuba): Hlabisa distr., Hluhluwe Game Reserve (-AA), *Ward 2439* (NU, NH); Hlabisa, Gunjanene area (-AB), *Ward 2709* (NU).

3. **Cassia biensis** (Steyaert) Mendonça & Torre in Bol. Soc. Brot. Ser. 2a, **29:** 33, Tab. 1, C, (1955); Exell & Mendonça in Con. Fl. Angol. **2:** 184, Tab. 38 C (1956); Schreiber in Prod. Südwestafrika, ed. Merxmuller, **59:** 11 (1967). Type: Angola, Bie, *Gossweiler 9* (BR, holo.).

C. katangensis (Ghesq.) Steyaert var. *biensis* Steyaert in Bull. Jard. bot. Etat Brux. **20:** 260 t. 10, E, F (1950).

The low-growing perennial, *C. biensis*, has not been previously considered in relation to South African species. There is little doubt of its affinity with *C. capensis*, especially var. *capensis*. This relationship is evident in growth form and leaf structure. There are differences, however, in its generally smaller size, especially flower size (Fig. 1 C1), its supra-axillary inflorescences, and an almost indefinable yet perceptible difference in leaflet venation (Fig. 2e).

Plants of *C. biensis* from South and South West Africa tend to look more nearly glabrous than do plants of *C. capensis*, possibly because they mostly lack the long patent hairs (Fig. 3c), which although lacking or sparse in var. *capensis*, must be considered a feature of *C. capensis* as a whole.

Probably because of the stalked petiolar gland (Fig. 1 B5), the entity *biensis* was first placed with *C. katangensis* as a variety. Bearing in mind its relationship to *C. capensis*, consideration was given during the present study, to

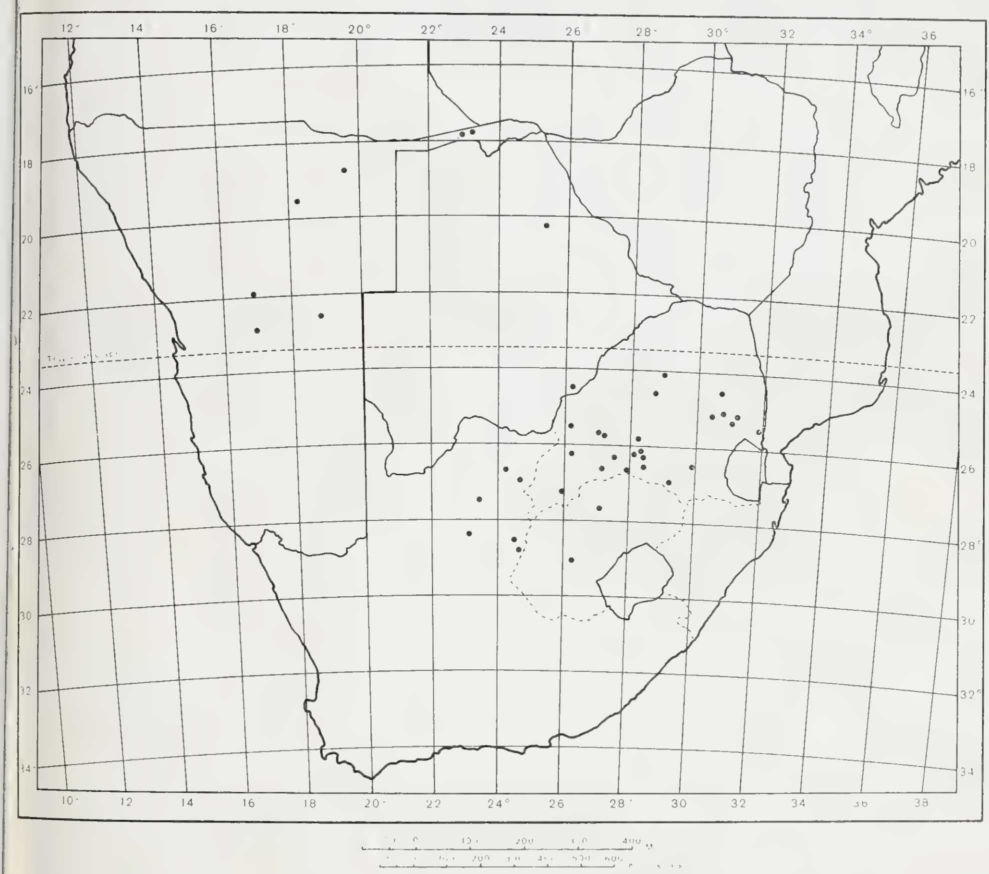

FIG. 6.
Cassia biensis—known distribution in southern Africa (excluding Rhodesia and Moçambique) up to 1974.

C. biensis being reduced again to varietal status under *C. capensis.* Morphological discontinuity does exist between the two taxa however, while there are also differences in distribution and in habitat tolerances. *C. biensis* must therefore remain a species. Plants are to be found growing under the dry, extreme climates of the central and western Transvaal, the Orange Free State, the northern Cape, Botswana and the less harsh parts of South West Africa (Fig. 6). Thus they seem more tolerant of drier habitat conditions than are plants of any of the varieties of *C. capensis.* The small flowers of *C. biensis* suggest this species may be inbreeding, as are some small flowered annual species within *Chamaecrista,* but this needs experimental confirmation.

Selected Citations

SOUTH WEST AFRICA—1819 (Karakuwisa): Okavango distr., Cigarette, n.e. of Karakuwise (-DB), *Maguire 2212* (PRE, WIND).

—2118 (Steinhausen): Gobabis distr., farm Steinhausen (-CC), *De Winter 2443* (PRE, WIND).

BOTSWANA—2025 (Mumpswe): Northern distr., Odiakwe, (-AB), *Wild & Drummond 6825* (PRE).

—2426 (Mochudi): Gaberones distr., Mochudi (-AC), *Harbor 17043* (PRE).

TRANSVAAL—2428 (Nylstroom): Potgietersrus distr., Percy Fyfe Nature Reserve (-BB), *Huntley 1114, 1237* (PRE).

—2430 (Pilgrim's Rest): Pilgrim's Rest distr., beyond Blyde R. Nature Reserve, Ohrigstad rd. (-DD), *Hilliard & Burtt 6031* (PRE, NU).

ORANGE FREE STATE—2727 (Kroonstad): Kroonstad distr., *Pont 352* (BLFU).

—2926 (Bloemfontein): Bloemfontein distr., Bloemfontein, near racecourse (-AA), *Potts 2922* (PRE, BLFU).

CAPE—2624 (Vryburg): farm Palmyra, 96 km. n.w. of Vryburg (-AA), *Rodin 3499* (PRE).

—2824 (Kimberley): Barkly West distr., Barkly West (-DA), *Wilman 1471* (PRE).

4. **Cassia falcinella** Oliv., Fl. Trop. Afr. **2**:281 (1871); Bak. f., in Leg. Trop. Afr.: 641 (1930); Ghesq. in Bull. Jard. bot. Etat Brux. **9**:162 (1932), excl. var. *longifolia;* Steyaert in Fl. Congo Belge **3**:520 (1952); Brenan in Kew Bull. **14**:178 (1960) et in F.T.E.A. Leg. (Caesal.): 90 (1967). Type: Tanganyika, Bukoba distr., Karagwe, *Grant 445* (K, holo.).

A variable species within which several infraspecific categories have been recognized. Of these, var. *longifolia* Ghesq. (1932) is no longer considered conspecific and is placed with *C. parva* Steyaert (Brenan 1960:178 & 1967:89). The other three, namely var. *parviflora* Steyaert (1950:251), var. *intermedia* Brenan (1960:178–9) and the typical variety, appear to divide the species satisfactorily in the opinion of the last-named author (loc. cit.). Var. *intermedia* and var. *falcinella*, which mainly differ in the nature and density of the indumentum of the stipules, are large flowered perennials entirely tropical African in distribution. It is only var. *parviflora*, a small flowered annual, that extends to southern Africa, reaching Rhodesia and northern South West Africa (Fig. 7).

——var. **parviflora** Steyaert, Bull. Jard. bot. Etat Brux. **20:** 251 (1950) et in Fl. Congo Belge **3:** 521 (1952); Brenan in Kew Bull. **14:** 178 (1960) et in F.T.E.A.

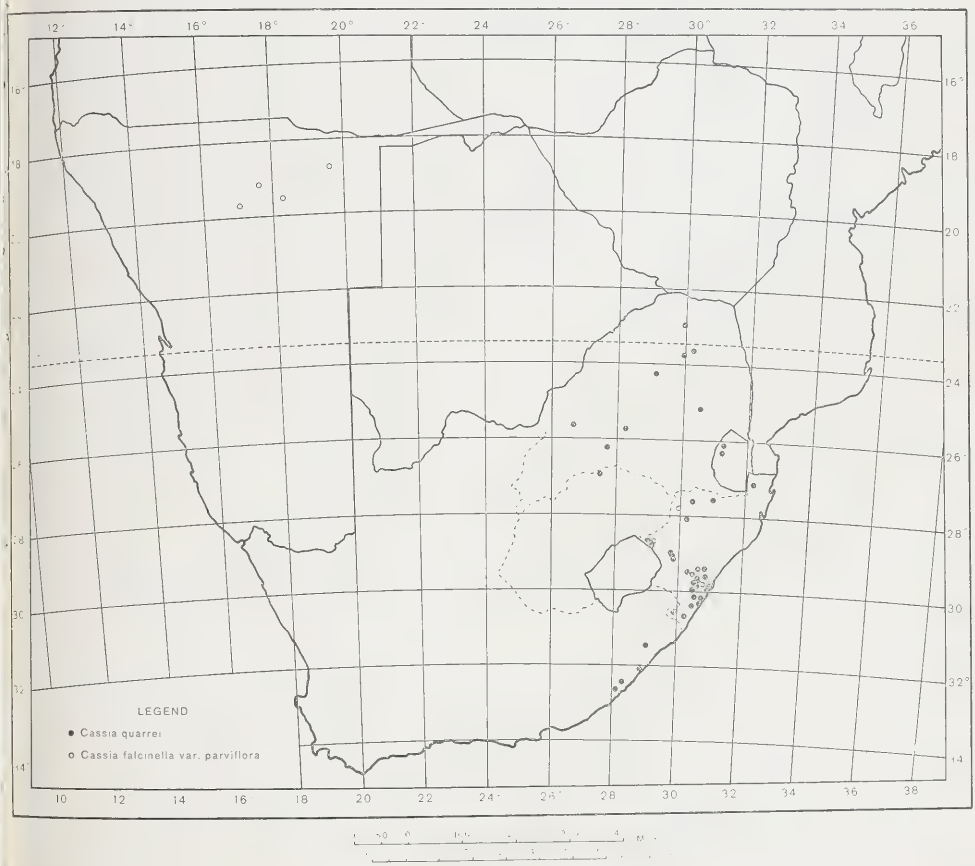

FIG. 7.
Cassia quarrei and *Cassia falcinella* var. *parviflora*—known distribution in southern Africa (excluding Rhodesia and Moçambique) up to 1974.

Leg. (Caesal.): 90 (1967); Schreiber in Prod. Südwestafrika, **59:** 11 (1967). Type: Rwanda Republic, Gabiro, *Becquet 613* (BR, holo.!).

In describing this variety Steyaert commented upon its relationship with *C. capensis*, but indicated there were differences in the supra-axillary inflorescences and the short pedicels. *C. capensis* also possesses very much larger flowers, slightly stalked petiolar glands (Fig. B7) and is perennial: in fact var. *parviflora* shows closer affinity with *C. biensis* which bears small flowers on short supra-axillary pedicels, but otherwise has most of the characters of *C. capensis*. It differs from *C. mimosoides*, another annual also present in South West Africa, in the channelled, not crested, adaxial surface to the leaf rhachis, the elliptical rather than round petiolar gland and the coarser, more hairy leaves with many fewer leaflet pairs. The stipules of var. *parviflora* are also slightly falcate rather than straight. Undoubtedly the closest relationships of this variety lie with *C. quarrei*, from which it differs in the much more marked asymmetry of its leaflet midrib (Fig. 2b). Plants have not been seen under field conditions, but some herbarium specimens show lateral branches that are at right angles to the main axis of growth. This should be checked upon to see whether it might prove a useful indicator character of the taxon. The annual habit and the small, pale flowers developed close to the stem suggest plants may be predominantly inbreeding.

Selected Citations

SOUTH WEST AFRICA—1819 (Karakuwisa): Cigarette, n.e. of Karakuwisa (-DD), *Maguire 2437* (NBG).

—1820 (Tarikora): Okavango distr., Ndonga Camp, *De Winter & Marais 4619* (PRE).

—1917 (Tsumeb): Tsumeb (-BB), *Dinter 1314* (NBG).

5. **Cassia quarrei** (Ghesq.) Steyaert, Bull. Jard. bot. Etat Brux. **20:** 264, Fig. 26 (1950); Steyaert in Fl. Congo Belg. **3:** 522 (1952); Brenan in F.T.E.A. Leg. (Caesal.): 95 (1967). Type: Congo Republic, Katanga, Étoile, *Quarré 380* (BR, lecto!).

Chamaecrista stricta E. Mey., Comm. Pl. Afr. Austr. **1:** 159 (1836). Type: South Africa, E. Cape Province, R. Bashee, *Drège* (K, iso.).

Cassia stricta (E. Mey.) Steud., Nom. ed. 2, 1: 308 (1840) non Schrank (1819).

C. mimosoides L. var. *stricta* (E. Mey.) Harv. in Fl. Cap. **2:** 273 (1862).

C. kirkii Oliv. var. *quarrei* Ghesq. in Bull. Jard. bot. Etat Brux. **9:** 153 (1932), pro parte sec. Steyaert.

C. capensis Thunb. var. *humifusa* Ghesq. in Bull. Jard. bot. Etat Brux. **9:** 164 (1932), pro parte, quoad *Robyns 2448* (BR).

Plants of *C. quarrei* are true annuals for they are not known to persist for more than a single growing season. The small, pale yellow flowers suggest they are inbreeders, which has been supported by evidence obtained from pot culture (Schorn & Gordon-Gray, in press). In these characters *C. quarrei* closely resembles *C. mimosoides* segregant *natalensis*, which is similar in general facies and which grows with *C. quarrei* over some of its range. These taxa are thus easily confused. They are best distinguished by the form of the adaxial surface of the leaf rhachis (Fig. 1 A1): staminal differences are also reliable.

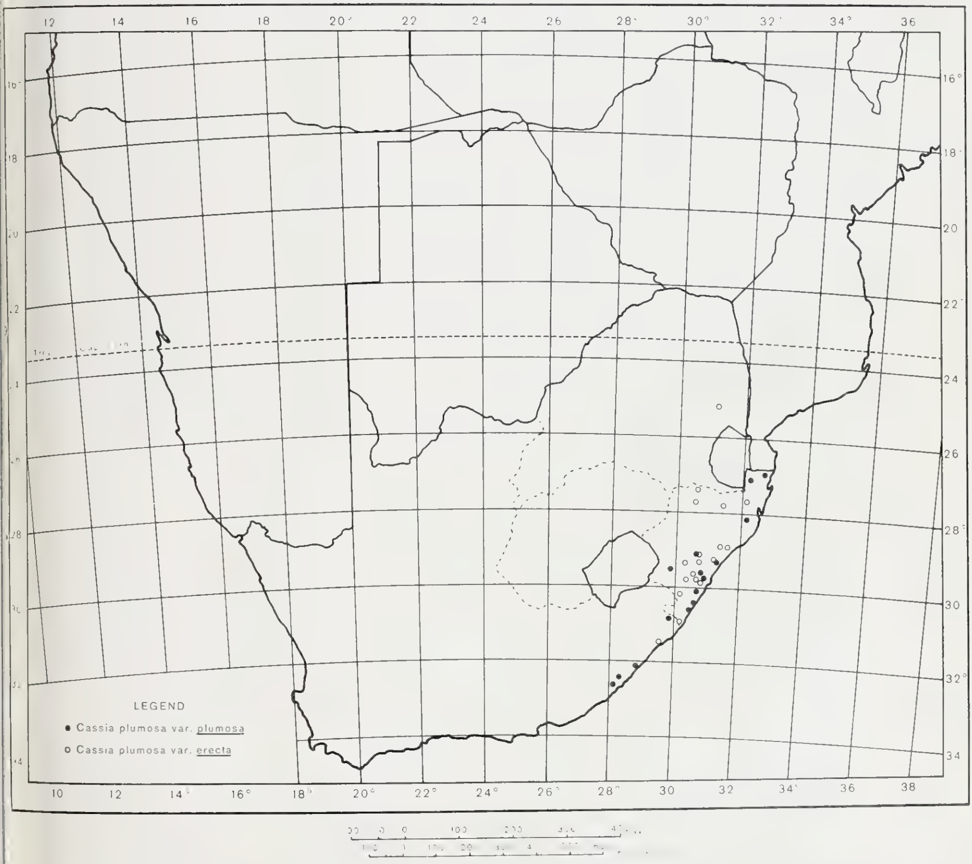

FIG. 8.
Cassia plumosa—known distribution in southern Africa (excluding Rhodesia and Moçambique) up to 1974.

C. quarrei exhibits little variability throughout its range in South Africa and specimens show close agreement morphologically with tropical examples, but no plants, either living or in herbaria, were found to have attained two to three metres, the height recorded for them by Steyaert (1950). Plants favour disturbed areas, especially roadsides, where extensive local populations may develop. As a weed *C. quarrei* is, however, not aggressive. A gathering made in 1967 shows that plants are still present at the mouth of the Bashee river from where Drège collected, before 1836, the specimen that was to become the type of Meyer's *Chamaecrista stricta*. (Figs. 1 B6; 2a; 7).

SELECTED CITATIONS

TRANSVAAL—2627 (Potchefstroom): Krugersdorp distr., farm "Gladysvale" nr. Krugersdorp (-BB), *Rodin 3926* (PRE).

SWAZILAND—2631 (Mbabane): Piggs Peak distr., between Piggs Peak and Mbabane (-AB), *Werdermann & Oberdieck 2205* (PRE).

ORANGE FREE STATE—2627 (Potchefstroom): Parys (-CD), *Potts 533* (BLFU).

NATAL—2830 (Dundee): Dannhauser distr., farm "Broadfields" (-AA), *Schorn 7* (NU, K).

—2929 (Underberg): Estcourt distr., Estcourt (-BB), *West 1790* PRE, NH).

—2930 (Pietermaritzburg): Umsindusi R. at foot of Braid St. (-CB), *Schorn 10* (NU).

CAPE—3228 (Butterworth)—Elliotdale distr., The Haven, Bashee R. mouth (-BB), *Gordon-Gray 1379* (NU).

6. **Cassia plumosa** (E. Mey.) Vogel, Syn. Gen. Cassiae: 65 (1837).

Chamaecrista plumosa E. Mey. in Comm. Pl. Afr. Austr. **1:** 159 (1836). Type: South Africa, E. Cape Province, between Bashee R. (Basche) and Umtata, alt. 1 500 ft., *Drège s.n.* (K, iso.).

At first glance *C. plumosa* resembles *C. capensis*. Both are large flowered, long petioled, perennial species that have a place in primary vegetation types, particularly of coast situations: neither are transient ruderals. But there are constant differences that distinguish them. Most important is the form of the leaf rhachis, which in *C. capensis* is channelled adaxially. This channel is not always clearly defined, its two margins sometimes adhering and obscuring the space between, but even so there is little chance of confusion with *C. plumosa* where a short crest of tissue is developed along the mid-axial line of the rhachis on its adaxial side. Viewed from the side, this wing is crenate in outline with the sinuses corresponding with the points of insertion of the leaflets: the crests of the crenations are usually ciliate (Fig. 1A2).

The crested leaf rhachis exhibited by *C. plumosa* is also a feature of *C. mimosoides* L., the best known species of *Chamaecrista*. It is thus hardly surprising that specimens of *C. plumosa* are frequently named *C. mimosoides*: indeed many workers in South Africa have treated the entity more correctly known as *C. plumosa*, as one of the forms of *C. mimosoides*. But the two are different: *C. mimosoides* is annual; *C. plumosa* perennial with a well defined

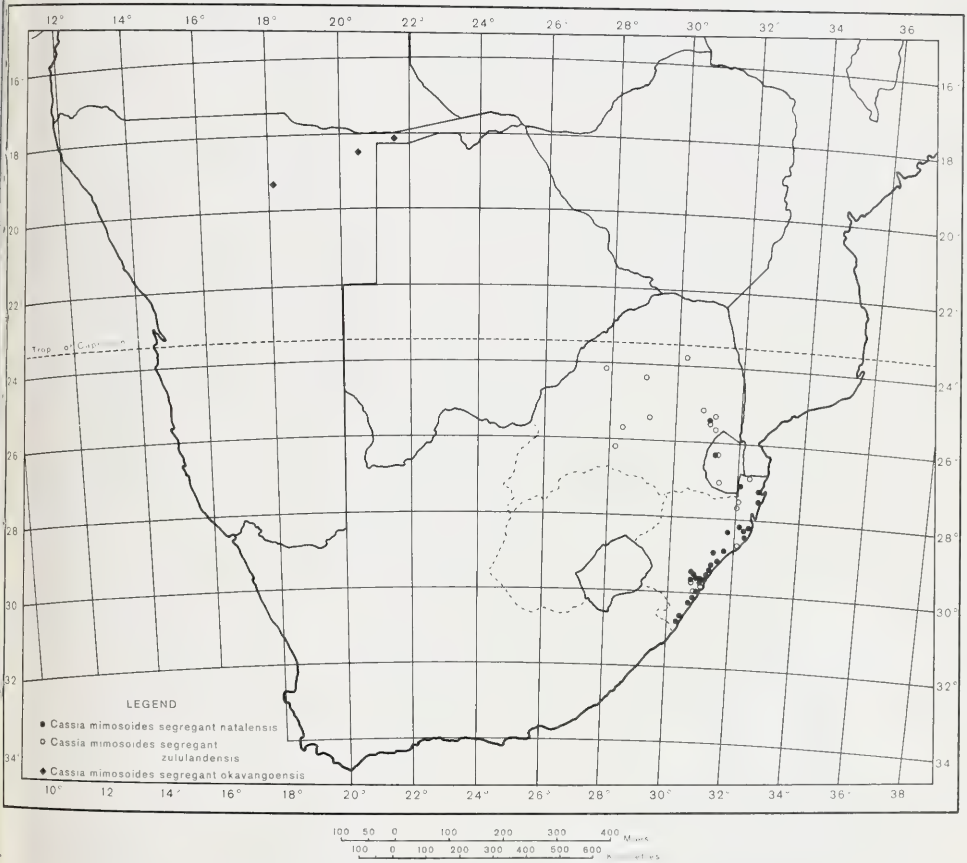
12° 14° 16° 18° 20° 22° 24° 26° 28° 30° 32° 34 36
16° 18 20 22 24 26 28 30 32 34°
Trop. of Cap...
LEGEND
● Cassia mimosoides segregant natalensis
○ Cassia mimosoides segregant zululandensis
◆ Cassia mimosoides segregant okavangoensis
10° 12 14° 16° 18° 20° 22° 24° 26° 28° 30° 32° 34° 36° 38
100 50 0 100 200 300 400 Miles
100 0 100 200 300 400 500 600 Kilometres

FIG. 9.
Cassia mimosoides—known distribution in southern Africa (excluding Rhodesia and Moçambique) up to 1974.

rootstock that develops, with time, numerous slender, horizontally-spreading ramifications.

C. plumosa is not homogeneous, the variability within it being almost as wide as is the case within *C. capensis* and *C. mimosoides*, the taxa with which it is most readily confused. An isotype at Kew of Drège's type agrees closely with *Ward 1873* from Hluhluwe, Natal (kindly compared by Dr. J. H. Ross). Ward's plant is representative of what must be considered typical *C. plumosa* (at least until Meyer's holotype has been located and compared). Such plants, in the field, are more or less rounded, compact, diffusely-branched, low-growing herbs or sub-suffrutices seldom exceeding 40 cm in height. Plants of some populations (for example, *Schorn 5* at Bothas Hill, Natal) are more or less prostrate, possibly having been pruned by grazing animals. The aerial parts of all specimens are glabrous, glabrescent or pubescent with appressed curved hairs (Fig.3b), while the leaves are glaucous. Variety *plumosa*, as this entity must be known taxonomically, is mainly coastal, extending from Moçambique through Natal into the Transkei and the Eastern Cape (Fig. 8). Populations grow usually in sand.

Meyer, 1837 under *Chamaecrista plumosa*, recognized variety *diffusa* (Type: South Africa, Cape Province, near Umzimkulu [Omsamculo], below 100 ft. alt., *Drège s.n.*—whereabouts unknown), which he distinguished from the type of var. *plumosa* on the more diffuse branching, smaller almost glabrous leaves with more pairs of leaflets, more clearly axillary pedicels and smaller flowers. Meyer, himself, stressed the exceedingly close relationship between type and variety, but notwithstanding, he believed the variety might stand. Another specimen from Umzimkulu (*Tyson 1167 p.p.*) falls within the limits of variety *plumosa*. This, as well as present study of the species in herbarium and field, suggests that Meyer's var. *diffusa* forms merely part of the range of var. *plumosa*. It is therefore not taken up here, but its status will need review if the type, when located, is found to differ appreciably from the type of *C. plumosa* var. *plumosa*.

A far more clearly defined variant within *C. plumosa* than variety *diffusa*, is an erect, spindly form that produces one, sometimes two, or few stems, from 0,4 to 1,25 m in height, from the perennial rootstock. These stems develop sparse willowy branches in the upper half. Such plants usually develop a velutinous indumentum of straight, patent hairs that is fulvus or yellow, and especially evident, even to the naked eye, on stems and the abaxial surfaces of leaflet rhachises (Fig. 3a). Sometimes, however, these characters are not correlated and tall, spindly, few stemmed plants may be densely or sparsely pubescent, or glabrescent, the hairs being curved and appressed.

Populations of these tall plants are common and find their best expression in the Camperdown district of Natal (especially the Inchanga area), but they are also frequent further inland to altitudes of approximately 700 m. They also occur in the eastern Transvaal and the Transkei. Many populations of these tall plants of *C. plumosa* are uniform and readily distinguished from the diffusely branched prostrate or more erect, rounded plants typical of the species. There are others in which the plants are more or less intermediate in growth form, degree of branching and indumentum. Such plants are not easy to place varietally, but in the field where growth form, texture and colour are more readily assessed, the distinctions are more apparent than in the herbarium.

The range of variability described for *C. plumosa* parallels closely that represented within *C. capensis* (see vars. *capensis* and *flavescens*). Since infraspecific taxa are already in use within *C. capensis*, variety *erecta* is established within *C. plumosa* to accommodate the tall, spindly plants, for the sake of uniformity.

——var. **erecta** Schorn and Gordon-Gray var. nov.

Plantae erectae, usque ad 2,5 m altae. *Caules* soli vel pauci a caudice, ramosi non nisi in dimidio superiore, plerumque velutini, saepe fulvi vel flavidi, vestiti pilis rectis, patentibus, flavidis, nonnunquam pubescentes vel glabrati, vestiti pilis curvatis, appressis. *Folia* 32–77 mm longa; foliola 23–46 juga, 4–7 mm longa 0,7–1,2 mm lata; glans petioli sessilis, circularis, ovata-elliptica vel elliptica, concavaque cyathiformis vel depressa superficiei, 0,3–0,8 (—1,6) mm longa, 0,3–0,8 mm lata; pedicelli 18–30 mm longi; petala 10–17 mm longa.

Holotypus varietatis: S. Africa, Natal, Camperdown distr., Inchanga, *Schorn 36* (NU). *Topotypi: Hilliard 2722; 3883* (NU)

It is possible that some of the variability within *C. plumosa* (especially some of that accommodated in var. *erecta*) is the result of sporadic hybridization with plants of another taxon of the Section *Chamaecrista* (possibly *C. mimosoides* segregant natalensis), for occasional plants such as *Ward 6743* (Durban distr., Reservoir Hills, NU, UDW) and *Strey 6568* (Hlabisa distr., Monzi Settlement, NU, NH) show a combination of characters suggestive of both these species. Field studies of populations in the localities where these plants were growing are needed.

C. plumosa, while being predominantly south-eastern in distribution, has relationship with some tropical African taxa. Brenan (1960: 185) established *C. polytricha* and distinguished it by its dense, longer, spreading indumentum from *C. plumosa* which he named as "probably its closest ally". This study has indicated that the presence of a velutinous indumentum consisting of long, spreading hairs is a common feature of *C. plumosa* var. *erecta* in South Africa. However, this variety may be distinguished from *C. polytricha* var. *polytricha*, by differences in leaflet venation and by the long-ciliate leaflet margins of the last-named taxon. The two other varieties recognised within *C. polytricha* are both annual. (Figs. 1 B12; 2h also apply to *C. plumosa*).

Selected Citations

var. *plumosa*

MOÇAMBIQUE—2235 (Mapinhane): Vilanculos (-AB), *Gomes e Sousa & Balsinhas 5110* (PRE).

NATAL—2732 (Ubombo): Ingwavuma distr., Vazi Swamp (-BB), *Moll 4742* (PRE, NU).

—2832 (Mtubatuba): Hluhluwe Game Reserve (-AA), *Ward 1873* (NH, NU).

—2930 (Pietermaritzburg): Camperdown distr., Botha's Hill (-DC), *Schorn 5* (NU).

CAPE—3029 (Kokstad): Umzimkulu distr., Clydesdale (-BD), *Tyson 1167 p.p.* (PRE, SAM).

—3228 (Butterworth): Komgha distr., near Kei Mouth, *Flanagan 1127* (PRE, GRA).

var. *erecta*

TRANSVAAL—2531 (Komatipoort): Nelspruit distr., n. of Whiteriver (-AC), *Grobbelaar 1098* (PRE).

NATAL—2731 (Louwsberg): Ngotshe distr., Ngome Forest (-CD), *Tinley 743* (NU).

—2831 (Nkandla): Eshowe distr., Hlinza Forest (-CD), *Edwards 2870* (PRE, NU).

—2930 (Pietermaritzburg): New Hanover distr., 2 ml. w. of Noodsberg (-BC), *Moll 1492* (PRE, NH, NU); Camperdown distr., Inchanga (-DA), *Schorn 36* (NU).

—3030 (Port Shepstone): Port Shepstone distr., 8 km. from Port Edward on Izingolweni rd. (-CC), *Hilliard 3042* (NU).

7. **Cassia mimosoides** L., Sp. Pl.: 379 (1753); Harv. in Harv. & Sond. Fl. Cap. **2:** 273 (1862) excl. vars.; Forbes in S. Afr. J. Sci. **18:** 344 (1922) excl. vars.; Burtt Davy in Fl. Plants & Ferns of Tvl. & Swaziland **2:** 325 (1932) excl. syn.; Steyaert in Bull. Jard. bot. Etat Brux. **20:** 236, 240, 247, Tab. 8 (1950) et in Fl. Congo Belge **3:** 514, Tab. 37 (1952); De Wit in Webbia, **11:** 283 (1955); Mendonça & Torre in Consp. Fl. Angol. **2:** 181 (1956); Brenan in F.T.E.A. Leg. (Caesal.): 100–103 (1967); Schreiber in Prod. Südwestafrika, **59:** 12 (1967). Types: Ceylon, Herb. Hermann vol. 2: 13,78 (BM, syn.).

Previous authors, among them Steyaert (1950) and Brenan (1967) have commented at length on the variability of this Asiatic and African species, and all who have attempted to treat it taxonomically have found difficulty in analysing its many forms. The type is from Sri-Lanka (Ceylon), but Steyaert (1950: 247) believed that the species was African rather than Asian, occupying the whole tropical zone to the south of the Sahara and extending, in the south west to the estuary of the Congo and perhaps the north of Angola, and in the south east to Lourenço Marques. He also believed it exhibited greater variability in Africa than in Asia. Brenan (1967) in revising *Cassia* in Tropical East Africa recognized within *C. mimosoides* seven groups to which he gave symbols but did not name. Three of these he stated extended into South Africa; one to the Transvaal; one to Natal; for the third no limit was given. There is no doubt that the species does extend into South Africa (Fig. 9). Schreiber (1967) recorded it for South West Africa; Compton (1966) for Swaziland; Jacot Guillarmod (1971) one specimen for Lesotho, and early workers such as Harvey (1862), Forbes (1922) and Burtt Davy (1932) for South Africa itself. The three last named authors considered the species in a broad sense, including within it, usually at varietal level, all South African representatives of the Section *Chamaecrista*. Notwithstanding this approach, it is certain that *C. mimosoides* in the narrow sense of the species accepted here, was represented in South Africa at the time of their work.

In this narrow sense, *C. mimosoides* may be distinguished from all other species of the Section *Chamaecrista* represented in the area of the *Flora of Southern Africa* by the following plexus of characters:

Plants annual, or perennating into a second season or longer if conditions are favourable, tap-rooted, never developing a perennial rhizomatous rootstock producing new aerial stems annually. Adaxial surface of the leaf rhachis crested, the crests, in profile, being symmetrically or asymmetrically crenate, or serrate.

Even when thus narrowly diagnosed, *C. mimosoides* is not without variability in the area under consideration. Three entities have been recognized within this species for this area. These are not morphologically discontinous and plants that do not fully conform to one entity or another (some of them are intermediate), are not uncommon. To some extent at least, the entities are linked with geography (and possibly habitat), as Brenan (1967: 100) stated was the case for tropical variants also, but to some extent, too, they are sympatric, for there is some degree of overlap between some of their ranges. These entities are themselves not entirely homogeneous, as will be indicated later.

Comparison of representatives of these entities against Hermann's types and against specimens of Brenan's groups in tropical Africa, led to the conclusion that in no case was agreement sufficiently precise to permit the recognition of direct relationships. With such extreme variability within the species, and with some parts of the range of *C. mimosoides* in Africa not yet fully documented (Rhodesia and Moçambique in particular), it would be unwise, indeed foolish, to attempt to establish formal infraspecific categories for the three Southern African entities.

For convenience, and since each is, to some extent, linked with geography, each is regarded as a segregant from the typical form and named according to the locality in which it is mainly represented.

The main characteristics of these segregants and their main areas of distribution are given in Table 1.

Table 1—More important morphological features of Southern African segregants within *C. mimosoides* L.

segregant	*natalensis*	*zululandensis*	*okavangoensis*
petiolar gland	sessile, elliptic, projecting laterally over petiole; 0,7–1,7 mm long; 0,5–1,0 (–1,3) mm wide	sessile, circular-elliptic or circular; 0,2–0,6 mm long; 0,2–0,3 mm wide.	sub-sessile to sessile, circular, usually 0,4 mm in diameter.
sculpturing of adaxial surface of leaflet rhachis	crested crests crenate both symmetric and asymmetric in same leaf	crested crests crenate both symmetric and asymmetric in same leaf	crested crests crenate asymmetric or serrate (different plants)
flower colour	pale yellow	creamy yellow	bright yellow
petal length	5,5–7,5 mm	5,0–7,5 mm	5,0–7,5–10,0 mm
pedicel length (at flowering)	(6,0–) 8,0–12,0 mm	5,0–14,0 mm	10–14 or 20–25 mm
indumentum			
stems	pubescent; hairs curved appressed	pubescent; hairs curved appressed	glabrescent; hairs curved appressed
ovaries	lanate; hairs fine, matted	lanate; hairs fine, matted	strigose: hairs coarse, straight
distribution	mainly coastal Natal; also Tvl., Swaziland, Moçambique	mainly coastal Zululand; also Tvl., Swaziland, Moçambique, Rhodesia	north-eastern South West Africa; possibly Botswana and Rhodesia

Segregant okavangoensis is a delicate annual with long feathery leaves; it can attain over 1½ metres in height with erect stems about 4 mm in diameter. It grows usually in sand and favours damp or wet conditions: presumably it can behave as a weed. In South West Africa it is not homogeneous but consists of two forms very closely related: the one is small flowered (petals 5,0–7,5 mm long) with fine, slender pedicels (20–25 mm long) and crests to the rhachis asymmetrically crenate in profile; the other is larger flowered (petals 7,5–10,0 mm long) with shorter pedicels (10–14 mm long) and crests to the rhachis markedly serrate in profile. The last form resembles Hermann's types from Sri-Lanka closely, but differs in the long, lateral branches usually developed from ground level, and the slightly larger flowers. Both these forms Schreiber (1967, 59: 12) accepted without comment as *C. mimosoides* and it may well be shown eventually that both fall within the range of variation of the species in its type locality (Figs. 1B 10, 11).

Table 2—Summary of the main characters used in identification of the Southern African (excluding Rhodesia and Moçambique) species of *Cassia*, Section *Chamaecrista*

Species	*Duration of Plant*	*Rhachis Form*	*Petiolar Gland*			*Relative Flower Size*
			Attachment	*Shape*	*Relative Size*	
comosa	perennial	channelled	sessile sunken	elliptic	large	large
capensis	perennial	channelled	short-stalked to subsessile	circular	small	large
biensis	perennial	channelled	short-stalked	circular	small	small
falcinella	annual	channelled	sessile	elliptic	medium	small
quarrei	annual	channelled	sessile	elliptic	medium	small
plumosa	perennial	crested	sessile	circular	medium-small	large
mimosoides	annual or short-lived perennial	crested	sessile or sub-sessile	elliptic or circular	medium-large or small	small to medium

Rhachis
- channelled
  - petiolar gland sunken in petiolar channel — *C. comosa*
  - petiolar gland not sunken
    - gland stalked or subsessile
      - small flowered (petals ± 7,5 mm long) —*C. biensis*
      - (petals ± 18,0 mm long) large flowered —*C. capensis*
    - gland sessile
      - plants of Eastern Southern Africa —*C. quarrei*
      - S.W.A. plants —*C. falcinella*
- crested
  - perennial—*C. plumosa*
  - annual—*C. mimosoides*

Diagrammatic Scheme for Rapid Preliminary Identification of Southern African (excluding Rhodesia and Moçambique) species of *Cassia*, Section *Chamaecrista*.
NOTE: When using this key refer to Fig. 1.

Segregant natalensis differs quite markedly in facies from segregant okavangoensis and may well eventually be given infra-specific status within *C. mimosoides*. The large elliptic petiolar gland (Fig. 1B 8) serves to distinguish it most convincingly, but there are several other differences including flower colour, pedicel length and indumentum to ovaries and stems that add to its different appearance. The elliptic petiolar gland is similar to that of *C. quarrei*: indeed this segregant may readily be confused with *C. quarrei* with which it sometimes grows. Another feature suggestive of *C. quarrei* is the nature of the crest to the adaxial rhachis surface, which is grooved along the summit, sometimes quite deeply, the margins of this groove being ciliate. Over much of its range, probably all of it, segregant natalensis is sympatric with *C. plumosa*. Evidence of *C. plumosa* is reflected in *C. mimosoides* segregant natalensis in the curve of the crests to the adaxial leaflet surface. These vary in individual leaves from symmetrically crenate (as in *C. plumosa*) to asymmetrically crenate (as in *C. mimosoides*). Whether these features of similarity reflect introgression in the past is uncertain at present.

Segregant zululandensis resembles segregant natalensis closely, differing mainly in the much smaller circular-elliptic to circular petiolar gland (Fig. 1B 9) that is characteristic of typical *C. mimosoides*. There are differences also in the plants being less robust and branching laterally from immediately above ground level, and the pale almost cream flowers. This segregant is not entirely homogeneous and included in it are freely branching plants with circular glands that produce deeper yellow flowers and longer petioles (both characters suggestive of segregant okavangoensis). Segregant zululandensis, in its pale flowered form, is most common in Zululand, particularly towards the coast, but it extends southwards as far as Durban and northwards into the Transvaal and Rhodesia. In the north the brighter yellow flowered, long pedicelled plants seem to predominate and may link with segregant okavangoensis, but this needs confirmation from further field study.

SELECTED CITATIONS

segregant okavangoensis

SOUTH WEST AFRICA—1820 (Tarikora): Grootfontein Nord distr., 16 km. n. of Tamso on Kapupahedi rd. (-BC), *De Winter & Marais 4728 p.p.* (PRE).

—1821 (Andara): Caprivi-Zipfel, Popa Fälle (-BA), *Merxmuller & Giess 2020* (PRE, WIND).

segregant natalensis

TRANSVAAL—2430 (Pilgrim's Rest): Pilgrim's Rest distr., Mariepskop (-BD), *Werderman & Oberdieck 1816* (PRE).

—2530 (Lydenburg): Nelspruit distr., *Breyer s.n.* (PRE, GRA).

SWAZILAND—without precise locality, *Stewart 8952* (GRA).

NATAL—2832 (Mtubatuba): Hlabisa distr., St. Lucia Estuary, e. side of Narrows (-AD), *Ward 4340* (PRE, NH, NU).

—2930 (Pietermaritzburg): Camperdown distr., Hammarsdale, nr. National rd. (-DA), *Schorn 4* (NU); Westville, Chiltern Hills (-DD), *Ward 6409* (NU, NDW).

—3030 (Port Shepstone): Port Shepstone distr., Uvongo (-CD), *Strey 9706* (PRE, NH, NU).

segregant zululandensis

TRANSVAAL—2430 (Pilgrim's Rest): Pilgrim's Rest distr., beyond Blyde R. Nature Reserve camp on Ohrigstad rd. (-DA), *Hilliard & Burtt 6031A* (PRE, GRA, NU).

—2530 (Lydenburg): Nelspruit distr., 5 km. s. of Nelspruit (-DB), *Leach 12072* (PRE, GRA).

SWAZILAND—2631 (Mbabane): Mbabane distr., Komati R., old ferry (-AA), *Compton 29826* (PRE); Hlatikulu distr., Malala, Kubuta Estate (-CD), *Pierce 2* (PRE).

NATAL—2632 (Bela Vista): Ngwavuma distr., Ndumu Game Reserve, Ndumu Hill (-CD), *Pooley 716* (NU).

—2732 (Ubombo); Ubombo distr., 8 km. n. of Jozini Dam (-AC), *Schorn 13* (NU).

—2930 (Pietermaritzburg): Durban distr., Isipingo Flats (-DD), *Ward 6527* (NU, UDW).

Key to Species and Infraspecific Taxa of Cassia, Section Chamaecrista, represented in Southern Africa (excluding Rhodesia and Moçambique).

1. Leaf rhachis channelled along adaxial (upper) surface 2
Leaf rhachis not channelled, but crested by an upright wing of tissue developed along the mid-line of the adaxial (upper) surface: this crest of tissue serrate, or symmetrically or asymmetrically crenate when seen in profile 10

2. Petiolar gland sessile, oval or elliptic, never circular 3
Petiolar gland raised on a short, or very short, stalk; if subsessile or sessile, then circular or circular-elliptic with a convex, flat or concave surface. Occasionally glands two, or rudimentary, or wanting 6

3. Petiolar gland completely or partially sunken in the channel on the adaxial surface of the petiole and usually separating the channel margins: gland generally exceeding 1,0 mm in length. Petals usually exceeding 7,5 mm in length. Plants perennial . . 4
Petiolar gland not sunken in the channel on the adaxial surface of the petiole, sometimes wider than the petiole and thus overlapping it: gland generally less than 1,0 (rarely to 1,2) mm long. Petals not exceeding 7,5 mm in length. Plants annual . . 5

4. Leaflets 3,0–7,0 mm wide. Gland sunken in the channel of the adaxial surface of the petiole, separating widely its margins and not, or hardly, visible when petiole is viewed from the side. Petals 10,0–15,0 mm long . . . . 1. **C. comosa** var. **comosa**
Leaflets 1,4–3,0 mm wide. Gland not completely sunken in the channel of the adaxial surface of the petiole, not separating so widely its margins, and usually clearly visible when petiole is viewed from the side. Petals 7,5–10,0 (–13,0) mm long . . . . 1. **C. comosa** var. **capricornia**

5. Stipules straight. Width of tissue to anticous side of main vein of leaflet approximately half width of tissue to posticous side of the same leaflet. Stamens 8 functional, 2 or 1 staminodal reduced to filiform threads difficult to detect or lacking. Recorded from Swaziland, the Transvaal, Natal and the eastern Cape . . . . 5. **C. quarrei**
Stipules slightly falcate. Width of tissue to anticous side of main vein of leaflet less than half width of tissue to posticous side of the same leaflet. Stamens 10, all clearly recognizable structurally, sometimes not all functional. Recorded from northern South West Africa . . . . 4. **C. falcinella** var. **parviflora**

6. Petiolar gland raised on a distinct slender stalk that is 1,0–1,5 mm long . . . . 2. **C. capensis,** segregant glandula-stipitata
Petiolar gland raised on a short stalk less than 1,0 mm long, or subsessile, or sessile 7

7. Petals not exceeding 7,5 mm in length. The majority of inflorescences clearly supra-axillary 8
Petals exceeding 7,5 mm in length. The majority of inflorescences axillary or almost so 9

8. Petiolar gland subsessile, or slightly raised on a short stalk. Plants perennial. Stems usually procumbent or decumbent . . . . 3. **C. biensis**
Petiolar gland sessile, never raised. Plants annual. Main stem erect, branching usually only above ground level, so that no branches are procumbent or decumbent . . 4. **C. falcinella** var. **parviflora**

9. *Stems with, or without, appressed or short patent hairs; if long patent hairs are interspersed these are few and scattered, so that any indumentum present does not appear villous or velutinous to the naked eye, hairs greyish-white, never fulvus or yellow. Petiolar gland slightly raised, circular. Channel to adaxial surface of rhachis well defined. Usually several prostrate or decumbent stems produced from a perennial rootstock . . . . 2. **C. capensis** var. **capensis**
Stems with appressed and/or short patent hairs with many long patent hairs interspersed, so that the indumentum appears villous or velutinous to the naked eye; indumentum, especially on young parts of stems, greyish-white, fulvus or bright yellow. Petiolar gland often obsolete or wanting, when present subsessile, elliptic-circular. Channel to adaxial surface of rhachis often poorly defined. Usually several robust, prostrate or decumbent stems produced from a perennial rootstock, or one or a few erect stems up to 90 cm high arising from a less definitely perennial rooting system. (Note: some erect, robust plants with poorly developed petiolar glands may be only glabrate) . . . . 2. **C. capensis** var. **flavescens**

10. The majority of pedicels, at flowering, exceeding 16 mm in length. 11
The majority of pedicels, at flowering, not exceeding 16 mm in length 14

11. Plants perennial. Crests to adaxial surface of leaflet rhachis symmetrically or asymmetrically crenate when viewed in profile. Petals usually exceeding 10,0 mm long, rarely from 7,5–10,0 mm. Recorded from Moçambique, Natal, the Transvaal and the eastern Cape 12
Plants annual. The majority of crests to the adaxial rhachis surface of a mature leaf asymmetrically crenate or serrate when viewed in profile (towards the leaf base some may be symmetrically crenate). Petals not exceeding 10,0 mm in length 13

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*Note: At points in the key marked with an asterisk occasional plants may prove intermediate and thus difficult to place conclusively with either of the alternatives.

12. *Plants more or less prostrate, much branched sub-suffrutices, or compact, more or less rounded diffusely branched herbs or sub-suffrutices usually not exceeding 40 cm in height. Leaves ± glaucous. Stems glabrous, glabrescent or pubescent with curved appressed hairs . . . . 6. **C. plumosa** var. **plumosa**

Plants erect, usually consisting of one or few stems from the perennial rootstock, these stems branching only above the middle to form a narrow rather spindly sub-shrub up to 2,5 m in height; occasionally shorter and more diffusely branched to form a ± compact, rounded sub-suffrutex 0,4 to 2,0 m in height. Leaves not markedly glaucous, sometimes yellowish green and puberulous especially towards the base abaxially. Stems villous, velutinous or densely pubescent to the naked eye, indumentum often fulvus or bright yellow, the hairs straight and patent. (Note: occasional erect, rather spindly plants may be glabrescent with the few hairs present curved and appressed) . . . . 6. **C. plumosa** var. **erecta**

13. *Petiolar gland sub-sessile or sessile, circular, usually ± 0,4 mm in diameter: stems glabrescent: ovaries strigose with coarse straight hairs. Petals usually bright yellow. Recorded from South West Africa . . 7. **C. mimosoides,** segregant okavangoensis
Petiolar gland sessile, circular or circular-elliptic, 0,2–0,6 mm long, 0,2–0,3 mm wide: stems pubescent with adpressed hairs: ovaries lanate with fine, more or less matted hairs. Petals usually cream or pale yellow. Recorded from eastern southern Africa, especially Zululand and Natal. . . 7. **C. mimosoides,** segregant zululandensis

14. *Petiolar gland elliptic, projecting laterally over petiole when viewed from abaxial leaf surface, 0,7–1,7 mm long, 0,5–1,0 (–1,3) mm wide . . . .
7. **C. mimosoides,** segregant natalensis
Petiolar gland circular or circular-elliptic, usually not projecting laterally over petiole when viewed from abaxial leaf surface, 0,2–0,6 mm long, 0,2–0,3 mm wide . . .
7. **C. mimosoides,** segregant zululandensis

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*Note: At points in the key marked with an asterisk occasional plants may prove intermediate and thus difficult to place conclusively with either of the alternatives.

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A NEW SPECIES OF *PECTINARIA* (ASCLEPIADACEAE)

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Abstract

A new species of *Pectinaria* is described from the lower Breede River Valley. This species, *P. stayneri* M. B. Bayer, is only represented by three plants collected by Mr. F. J. Stayner near Infanta in 1971.

Uittreksel

'N NUWE SOORT *PECTINARIA* (ASCLEPIADACEAE)

Die nuwe soort, *Pectinaria stayneri* M. B. Bayer, is in 1971 deur Mnr. F. J. Stayner naby Infanta versamel. Dit word deur net drie plante verteenwoordig.

Introduction

The genus *Pectinaria* Haworth is a somewhat heterogenous one, in which the principle distinguishing character is that the corolla lobes are joined at the tips. This is a character frequently observed in for example *Stapelia rufa* Masson, but the absence of which is used to distinguish *P. mirkinii* Pillans and also *P. tulipiflora* Luckhoff. The coronal structure is the main criterion for the recognition of genera in the tribe *Stapeliae* and in *Pectinaria* this may be of three types. In the first the corona forms an outer pectinate ring with small inner lobes incumbent on the anthers; in the second the outer lobes are reduced, but large dorsal processes are present on the incumbent inner lobes; and thirdly those in which the inner lobes are frequently erect above the anthers, with reduced dorsal processes and outer lobes.

The first group with the pectinate coronal ring includes *P. articulata* Haw. and *P. asperiflora* N. E. Brown. The former species was collected by Thunberg in the Roggeveld mountains in 1773. Brown separated his species on the basis of curious spinescent papillae on the inner surfaces of the corolla. The presence or absence of papillae was never given for *P. articulata* and Brown, in the absence of a type, was not correct in basing a new species on this character alone. Field observations now indicate three closely related elements characterised by having short stout, conically tuberculate stems. These are firstly an element found throughout the Ceres Karoo and part of the Little Karoo and which is usually referred to as *P. asperiflora* because of the spinescent papillae inside the corolla.

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Secondly there is the element named as *P. articulata* var. *namaquensis* N. E. Brown from western Bushmanland in which the flower colour is yellowish green and where the papillae are apparently unarmed following the original description. In fact specimens collected from south-east of Springbok have definitely been observed in which the papillae are armed with small concolorous spines. Thirdly there is an as yet unnamed element from northwest of Sutherland collected by H. Hall in which the connivent corolla lobes do not exceed the tube and in which the papillae are long and armed with small blunt tuberculi rather than sharp spines.

In the second group with pronounced dorsal processes on the inner coronal lobes, the stems are thin (less than 1 cm diam.), obtusely 4-angled and the small flowers are creamy-white and purple inside at the base of the tube. *P. arcuata* N. E. Brown was first described from the Bedford area of the eastern Cape as having narrow pointed flowers with typically connivent corolla lobes. *P. mirkinii*, in which the corolla lobes were said to be free, was later described from Steytlerville. A collection by the writer from Knoetze near Willowmore indicated that the only basis for the recognition of *P. mirkinii* is that the corona is much larger than in *P. arcuata* and this character is probably related to the free corolla lobes in the former species. It seems that there is little ground for really treating these as discrete species.

In the third group with erect narrow coronal lobes, four nearly geographically complementary elements can be distinguished. *P. pillansii* N. E. Brown

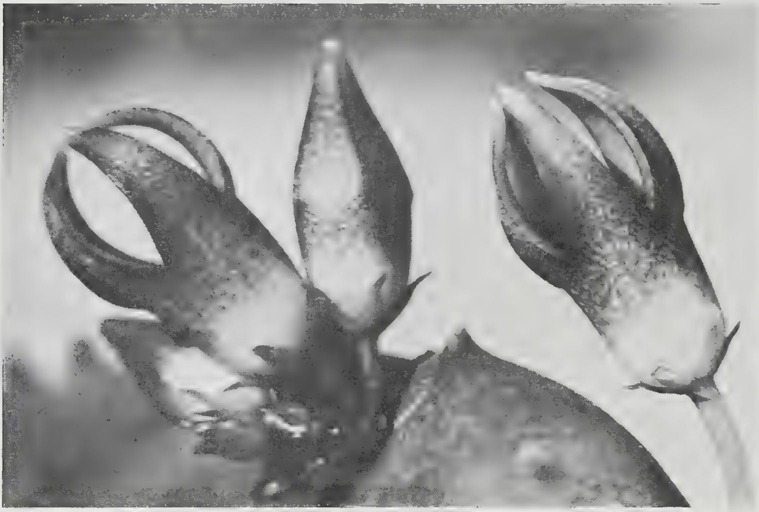

Fig. 1.
KG/731/71 *Pectinaria stayneri* Bayer sp. nov. from the lower Breede River Valley near Infanta (3420 BD Bredasdorp.)

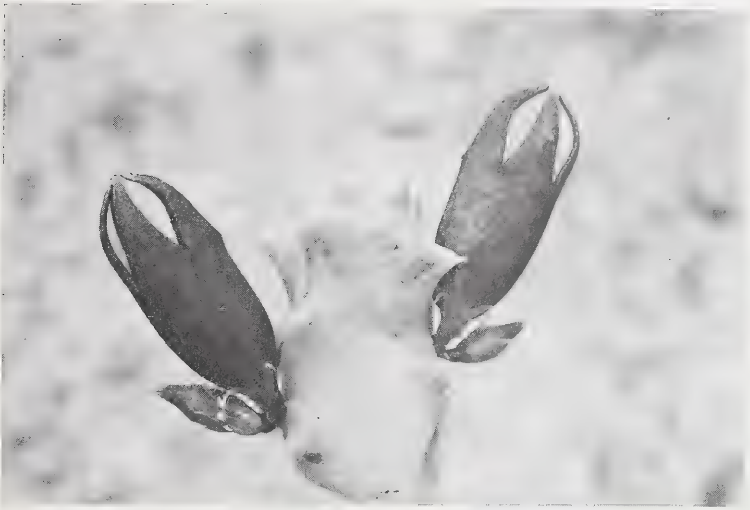

FIG. 2.

KG 232/62 *Pectinaria saxatalis* N. E. Brown, a form with abnormally narrow flowers from the Hex River Valley at Worcester (3319 CB Worcester.)

from Somerset East is easily separated by its brownish subterranean flower with thick decurved intermediate corolla lobes. *P. breviloba* Dyer from the Robertson Karoo has a characteristic very short lobed flower and the thin stems and growth habit are also characteristic. *P. saxatalis* N. E. Brown is widespread and variable. *P. tulipiflora* Luckhoff from the foot of Van Rhyns Pass was separated on the basis of yellow coronal colour, slender stems, absence of frosted appearance inside the corolla, and "delicate" appearance of the flower. The writer has observed yellow coronal colouration in *P. saxatalis* as it occurs at Laingsburg as well as free corolla lobes which result in the "tulip" shape. In plants collected at Van Rhyns Pass the inside corollae have had sparse pilose hairs and the same minute aculae found in *P. saxatalis*. The only reasonable distinction remaining is that of size and it appears that *P. tulipiflora* is little more than a geographic variant of *P. saxatalis* extending across the Ceres Karoo where this species is uncommon.

The fourth and final element in this group is a species collected by Mr. F. J. Stayner near Infanta at the mouth of the Breede River. *P. saxatalis* is not known south of the Langeberg mountains east of Robertson and in *P. stayneri* described below there are several distinctions. These include the smaller subcampanulate flowers, stems half as thick as in *P. saxatalis* and perhaps the distinctive bee-hive-like smell.

Pectinaria stayneri M. B. Bayer sp. nov. (Asclepiadaceae—Stapeliae).

Caules procumbentes, usque ad 14 cm longi, ad 1 cm crassi, acute tetragoni, glabri, dentati. *Flores* 3-8, aggregati, prope basim remorum juniorum; *pedicelli* 3 mm longi; *corolla* purpurea pallida, subter albida, tubo angusto 3 mm longo, 3 mm diam.; *lobi* 6 mm longi, conniventes vel libere patentes, diam. 5 mm ubi conniventes; *corona* non stipitata; *lobi exteriores* luteus, brevitur deltoidi; *lobi interiores* fuscus, alaeformes, umbonati, 4,5 mm alti, 1 mm lati, apices conniventes.

Stems procumbent, dull green, glabrous, up to 14 cm long and 1 cm square, acutely 4-angled with slightly channelled sides and small subretrorse deltoid teeth up to 2 mm long, 7-9 mm apart. *Flowers* in clusters of up to 8 at the bases of the younger stems; *pedicels* up to 3 mm long, *sepals* up to 3 mm long, spreading, ovate-acuminate; *corolla* erect or suberect, 3 mm diam. at base, 5 mm across lobes when these are connivent, *tube* 3 mm long, *lobes* 6 mm long connivent or free; *corona* outer lobes small yellow shortly deltoid, less than 1 mm long, inner lobes erect 3 mm long, 0,5 mm broad, hump backed, connivent above anthers. *Flowering* January—May.

Type: West bank of the Breede River, about 8 km inland from Infanta, *F. J. Stayner KG 731/71* (NBG, holo.).

P. stayneri is named in honour of the collector Mr. F. J. Stayner who was curator of the Karoo Botanic Garden from 1959 to 1973. It is probable that this near relative of *P. saxatalis* is confined to the rocky banks of the lower Breede River, growing in association with *Duvalia maculata* N. E. Br. var. *immaculata* Luckhoff, *Gasteria verrucosa* (Mill.) Duv. and other succulents.

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STUDIES IN THE GENERA OF THE *DIOSMEAE* (RUTACEAE): 5

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ABSTRACT

Two new species of *Euchaetis*, one from the vicinity of Albertinia and the other from the vicinity of Riversdale, three new species of *Diosma*, one from the mountains near Riviersonderend, one from the Baviaanskloof and one from near Mossel Bay, and one new species of *Macrostylis* from the plains near Elim are described.

UITTREKSEL

STUDIES IN DIE GENERA VAN DIE *DIOSMEAE* (RUTACEAE): 5
Twee nuwe *Euchaetis* soorte, drie nuwe *Diosma* soorte, en een nuwe *Macrostylis* soort word beskryf.

Euchaetis albertiniana Williams sp.nov. propria propter folia appressa lanceolata, sepala ciliata, antheras glandulis 0,3 mm longis acutis coronatas.

Frutex 30–50 cm, erectus, diffusus, gracilis, ad basim monocaulis. *Rami* recti, graciles, dichotomi, glabrescentes. *Ramuli* brevi, graciles, puberuli. *Folia* 3–5 mm longa, 1,2–1,7 mm lata, elliptica vel lanceolata, acuta, minute callosa, sub-trigona, serrulata, glabra, glanduloso-punctata, sessilia, appressa, decussata. *Inflorescentia* terminalis, bini. *Flos* 5 mm diam., albus vel sub-roseus. *Bractea* 1,5–2 mm longa, 1–1,1 mm lata, elliptica, minute callosa, ciliolata, glabra, glanduloso-punctata, sessilis. *Bracteolae* duae, 1,5–1,7 mm longae, 0,7–1 mm latae, apicibus incrassantis, marginibus hyalanis ciliolatis, in medio glanduloso-punctata. *Sepala* quinque, 1,7–1,8 mm longa, 1,7–2,1 mm lata, irregularia, apicibus incrassatis viridis, marginibus hyalinis latis ciliatis. *Petala* quinque, 3,5–4 mm longa, 2–2,6 mm lata, transverse barbata, ad basim ciliata. *Staminodia* quinque, 0,05–0,1 mm diam., vestigialia. *Fila* quinque, 1,5–1,9 mm longa, glabra. *Antherae* quinque, ante anthesin 0,8–1,2 mm longae, 0,6–0,7 mm latae, aurantiacae vel vinosae, glandula 3 mm longa coronata. *Pollen* 45–50μ longum, 28μ diam., ellipsoideum. *Discus* viridus, succulentus, ovarium excedens, nectarifer. *Stigma* 0,4–0,5 mm diam., globosum, capitatum, viridum. *Stylus* 1 mm longus, erectus, glaber, persistens. *Ovarium* 5-carpellatum, 0,8 mm longum, 0,7 mm diam., ad apice minute pilosum. *Fructus* 5-carpellatus, 4,5 mm longus,

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levis, glanduloso-punctatus. *Cornua* perbrevia, patentia, apicibus bifidis, minute pilosis, glanduliferis. *Semen* 3 mm longum, 1,3 mm latum, piceum, nitens.

Type: CAPE—3421 (Riversdale): Near Askop on south side of road 16 km west of Albertinia (-AB), 180 m alt., 2/3/1974 *Williams 1879* (NBG, holotype; K, PRE, STE, isotypes).

It would appear that this plant was first collected by Dr. J. Muir in 1913 near Albertinia. He mentions it on page 35 in his paper on "The Vegetation of the Riversdale Area", published in 1929, under the name *Euchaetis burchellii*. This is a closely related species differing however in several important respects from the plant here described for the first time.

Shrubs 30–50 cm tall, erect, diffuse, slender, single stemmed towards the base. *Branches* erect, slender, dichotomous, glabrescent. *Branchlets* short, slender, pubescent with very short erect white hairs. *Leaves* 3–5 mm long, 1,2–1,7 mm broad, elliptic or lanceolate, acute, apex minutely callused, hyaline margins very narrow and ciliate with short stout hairs fairly widely spaced, sub-triangular in cross section, channelled on the inside when dry, gland dotted along either side of the midrib and with smaller glands along the margins, glabrous, sessile, adpressed, erect, decussate. *Inflorescence* terminal, with the flowers normally in pairs, white or pinkish, 5 mm diam. *Bract* one to each flower, 1,5–2 mm long, 1–1,1 mm broad, elliptic, obtuse with a minute apical callus, margins ciliolate, glabrous, gland dotted, sessile. *Bracteoles* two, 1,5–1,7 mm long, 0,7–1 mm broad, irregular in outline with a thick green apex, midrib gland dotted, hyaline margins broad, ciliolate, adaxial surface with a few very short bristly hairs. *Calyx lobes* five, 1,7–1,8 mm long, 1,7–2,1 mm broad, irregular in outline, with a thick green apex and broad ciliate hyaline margins, adaxial surface pubescent. *Petals* five, 3,5–4 mm long. *Limb* 2–2,6 mm broad, orbicular, retuse, glabrous, with a few gland dots. *Claw* 2 mm long, narrowing to the base, transversely bearded above with a few hairs down the midrib, ciliate. *Staminodes* five, 0,05–0,1 mm diam., vestigial. *Filaments* five, 1,5–1,9 mm long, glabrous. *Anthers* five, 0,8–1,2 mm long, 0,6–0,7 mm broad, orange or wine coloured, with an apical gland 3 mm long. *Pollen* 45–50μ long, 28μ diam., ellipsoid. *Disc* exceeds the ovary, green, fleshy, exudes nectar. *Stigma* 0,4–0,5 mm diam., globose, capitate, green, persisting. *Style* 1 mm long, erect, glabrous, persisting. *Ovary* 5-carpellate, 0,8 mm long, 0,7 mm diam., each carpel with a globose gland at the apex surrounded by a few very short hairs. *Fruit* 5-carpellate; *carpels* 4,5 mm long, smooth, gland dotted, reddened on the outside; *horns* about 1 mm long, spreading at 45°, apices bristly, bifid with a gland. *Seed* 3 mm long, 1,3 mm broad, black, shining.

SPECIMENS EXAMINED

CAPE—3421 (Riversdale): near Askop on south side of road 16 km west of Albertinia, (-AB), 180 m alt., 2/3/1974 *Williams 1897* (NBG, K, PRE, STE);

10 miles west of Albertinia (-AB), 4/4/1952 *Lewis 4139* (SAM), 4/4/1952 *Compton 23324* (NBG); Sandy flats 6 miles west of Albertinia (-AB), 13/4/1962 *Lewis 5921* (NBG): National Road near Albertinia in sand (-BA), 7/12/1951 *Esterhuysen 19515* (BOL, K, NBG); Albertinia (-BA), 10/11/1952 *Middlemost 1829* (BOL, NBG, SAM), 17/12/1949 *Martin 6* (NBG) Roggeland near Albertinia (-BA), 5/5/1913 *Muir 843* (PRE, SAM); less than 1 km NNW of Albertinia (-BA), 600 ft., 6/7/1973 *Williams 1821* (BOL, C, GRA, NBG, K, M, MO, PRE, S, STE); sandy hills between Albertinia and Ystervarkfontein (-BA), 1 000 ft., 9/3/1966 *Rourke 353* (NBG, STE); Asvogelberg hills between Albertinia and Melkhoutfontein (-BA), 10/6/1966 *Rourke 461* (NBG); 10 miles south of Albertinia (-BC), 600 ft., 30/7/1962 *Acocks 22551* (STE); Ystervarkfontein, sandveld near sea (-BC), 200 ft., *Bayliss BRI 181* (GRA, NBG).

DISTRIBUTION AND BIOLOGY

Euchaetis albertiniana is found in a fairly small area beginning in the vicinity of the town of Albertinia and extending a few miles westwards. It grows on deep sandy soil at altitudes of 60 to 300 m (200 to 1 000 feet) above sea level. The flowering season has not been closely studied due to the small number of collections made, but it would appear to extend at least from November until July. Ripe fruits have been gathered in March and April. Pollination is most probably by insects and the ripe seeds are ejected by the usual catapult mechanism. Regeneration from seed takes place after fires. The leaves have a faint smell of turpentine or eucalyptus when crushed.

DISCUSSION

This plant appears in most respects to be a typical *Euchaetis*. (1) The *flowers* are in pairs. (2) The *petals* are transversely bearded. (3) *Staminodes* are vestigial. (4) The *anther* possesses a small apical gland which is rather larger than normal. (5) The *disc* is well developed and exceeds the ovary. (6) The *stigma* is capitate. (7) The *style* is short. (8) The *filaments* and *style* are glabrous. (9) The *ovary* is 5-carpellate.

Euchaetis albertiniana is recognised as distinct from *E. burchellii* in that it is destroyed by fires whereas *E. burchellii* develops a stout rootstock from which it may regenerate after fires. Unfortunately this valuable character is seldom noted on a herbarium sheet. Among other characteristic differences one may, however, see that the leaves in *E. albertiniana* are often adpressed, ciliolate with an apical callus, whereas those of *E. burchellii* are never so. The anther in *E. albertiniana* possesses a small pointed gland, but that of *E. burchellii* is minute. *E. albertiniana* is also closely related to *Euchaetis laevigata* Turcz. but differs in that the leaves of *E. laevigata* are complicate, orbicular, spreading and somewhat more recurved towards the apex. The apical gland on the anther in

E. laevigata is minute as in *E. burchellii* but not in *E. albertiniana*. *E. burchellii* is found in sandy soil fairly near the coast from near Great Brak River in the east to Uilenkraal River near Gans Baai in the west. *E. laevigata* occurs on limestone hills near Bredasdorp. The name refers to the locality where this species occurs.

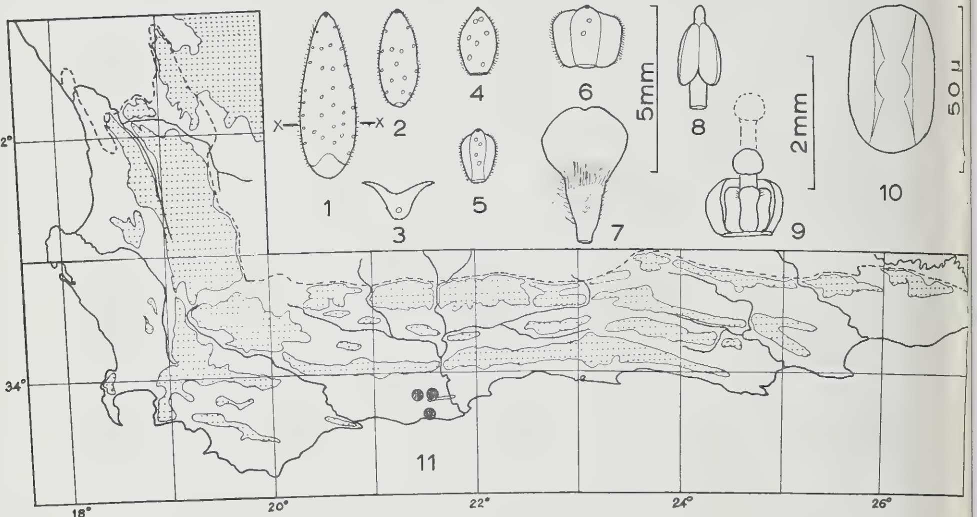

Fig. 1.
Euchaetis albertiniana: 1. Leaf; 2. Leaf; 3. Section of Leaf; 4. Bract; 5. Bracteole; 6. Calyx lobe; 7. Petal; 8. Anther; 9. Gynoecium; 10. Pollen; 11. Distribution.

Euchaetis longicornis Williams, sp.nov. propria propter folia erecta, bracteas et bracteolas subulatas, sepala acuminata, fructum cornua longa ferentem.

Frutex 30–100 cm, erectiuscula, ad basim monocaulis. *Rami* brevi, asperi, glabrescenti. *Ramuli* erecti, brevi, graciliusculi, foliosi, puberuli. *Folia* 13–15 mm longa, 1 mm lata, sub-teretia, subulata, eciliata, glandulosa-punctata, scabrida, breve petiolata, crebra, erecta, dispersa. *Inflorescentia* terminalis, aggregata. *Flos* 3 mm diam. *Pedicellus* 2 mm longus, puberulus, in medio bracteolatus. *Bractea* extima 6,5–7 mm lata, subulata, sparsim puberula, glanduloso-punctata, minute ciliolata; intima bracteolae similis. *Bracteolae* duae, 4 mm longae, similis bractearum. *Sepala* quinque, 4–4,5 mm longa, ad basim 1,7 mm lata, acuminata, sparsim puberula, ciliolata. *Petala* quinque, 3,5–4 mm longa, 1–1,2 mm lata, oblonga, sub-acuta, transverse-barbata, ad basim ciliata, serrulata. *Staminodia* quinque, vestigialia, 0,2 mm diam. *Fila* quinque, post anthesim

1,2 mm longa. *Antherae* quinque, ante anthesim 1,1 mm longae, 0,76 mm latae, vinosae, apicibus minute glandulosis. *Pollen* 37–45μ longum, 23–22μ diam., oblongum. *Discus* 5-sinuato-crenulatus, viridus, apertus, nectarifer, ovarium excedens. *Stigma* 0,2 mm diam., capitellatum, globosum, viridum. *Stylus* 1,6 mm longus, erectus, glaber. *Ovarium* 5-carpellatum, 0,5 mm longum, 0,7 mm diam. *Fructus* 5-carpellatus, 13 mm longus, glaber, glanduloso-punctatus, striatus, cornibus 7 mm longis, erectis, gracilibus. *Semen* 5–6 mm longum, piceum, nitens.

Type: CAPE—3421 (Riversdale): On the north slopes of Plaatjieskop between the Kaffirkuils and Soetmelks rivers (-AB), 240 m alt., 3/5/1974 *Williams 1896* (NBG, holotype; K, MO, M, PRE, S, STE, isotypes).

On the 20th of November 1814 William Burchell collected this plant "near our station at Zoetmelks River along the road west 1 mile". He wrote the manuscript name *Diosma quinquecornu* and a short description on his collecting ticket. Using this information, one hundred and sixty years later, the author was very easily able to rediscover this unique plant in exactly the same locality.

Shrubs 30–100 cm tall, fairly erect, spreading up to 1,20 m wide, not dense, arising from a single stem at ground level. *Bark* dark brown, smooth with small leaf scars on the lower branches. *Branches* short, glabrescent, knotty with raised leaf scars. *Branchlets* short, fairly slender, leafy, clothed with a short dense white pubescence. *Leaves* 13–15 mm long, 1 mm broad, sub-terete, subulate, eciliate, gland-dotted, scabrid, with a short reddish petiole, crowded, subimbricate, fairly erect, somewhat falcate when dry, scattered. *Inflorescence* a much reduced compound raceme with *flowers* 1–3nate, 3 mm diam., star shaped, white, opening in succession, more or less surrounded by the uppermost leaves. *Pedicel* 2 mm long, puberulous, with a pair of bracteoles about the middle. *Bract* 6,5–7 mm long, 0,7 mm broad, subulate, sparsely puberulous, gland-dotted, minutely ciliolate; the innermost 4 mm long. *Bracteoles* two, 4 mm long, otherwise similar to the bracts. *Calyx lobes* five, 4–4,5 mm long, 1,7 mm broad below, acuminate, sparsely puberulous, ciliolate. *Petals* five, 3,5–4 mm long, 1–1,2 mm broad, oblong, sub-acute, margins of limb somewhat serrulate. *Claw* transversely bearded, ciliate. The beard and cilia enclose the reproductive parts of the flower in a delicate cage. *Staminodes* five, 0,2 mm diam., vestigial, a sessile spherical gland at the apex of each lobe of the disc. *Filaments* five, becoming 1,2 mm long after anthesis, bearing a very few minute hairs. *Anthers* five, before anthesis 1,1 mm long, 0,75 mm broad, wine coloured, with a minute apical gland. *Pollen* 37–45μ long, 23–22μ diam., oblong. *Disc* 10-sinuate, green, stands open, exceeds the ovary, exudes nectar. *Stigma* 0,2 mm diam., capitellate, globose, green. *Style* 1,6 mm long, erect, glabrous, the lower half not shrinking so much when withered. *Ovary* 5-carpellate, 0,5 mm long, 0,7 mm diam., with one or at most two small hairs on each lobe. *Fruit* 5-carpellate, 13 mm long, glabrous, gland-dotted, striate veined with *horns* 7 mm long, erect, slender. *Seed* 5–6 mm long, black, shining.

Specimens Examined

CAPE—3421 (Riversdale): Near our station at Zoetmelks River along the road west 1 mile (-AB), 20/11/1814 *Burchell 6740* (K, P); on the north slopes of Plaatjieskop between the Kaffirkuils and Soetmelks Rivers (-AB), 240 m alt. 3/5/1974 *Williams 1896* (NBG, K, M, MO, PRE, S, STE) Riversdale Nature Reserve, near trig. beacon (-AB), 800′, 3/6/1970 *Taylor 7734* (STE).

Distribution and Biology

Many hilltops on the plain between Bredasdorp and Albertinia are capped with a horizontal layer of silcrete which has slowed down the rate of erosion and provided on the slopes below small "islands" of soil differing from the surrounding cultivated lands. *Euchaetis longicornis*, although quite accessible, has so seldom been collected that one expects it to be endemic to a very small area and even possibly a relic with a previously much more extensive distribution. It is unusual in that it is the only species of *Euchaetis* with really sharp pointed leaves, quite unpleasant to touch, it bears fruits with by far the longest horns in the genus and its flowers give off a strong foetid smell. This smell is a character which I have, as yet, not noted in any other plant in the *Diosmeae*. The leaves of all the *Diosmeae* release odours of more or less pungency from their oil glands when crushed. However the foetid odour given off not by the oil glands but by the tiny flowers of *E. longicornis* can permeate a whole room. Pollination is most certainly by insects of which many different kinds were observed visiting the flowers. When ripe the seeds are ejected by the usual catapult mechanism and, as this plant does not coppice after fires, regeneration must take place from seed. The leaves give off a sweet smell reminiscent of eucalyptus when crushed.

Discussion

This plant is placed in the genus *Euchaetis* Bartl. & Wendl. because it possesses the following characters: (1) *Flowers* 1–3nate. (2) *Petals* transversely bearded. (3) *Staminodes* vestigial. (4) *Anther* with a minute apical gland. (5) *Disc* well developed, exceeds the ovary. (6) *Stigma* capitellate. (7) *Style* short and glabrous. (8) *Filament* virtually glabrous. (9) *Ovary* 5-carpellate.

Euchaetis longicornis is recognised as distinct on account of its having subulate leaves, sharply pointed bracts and bracteoles, acuminate calyx lobes and a fruit with exceptionally long horns, a character to which the name refers.

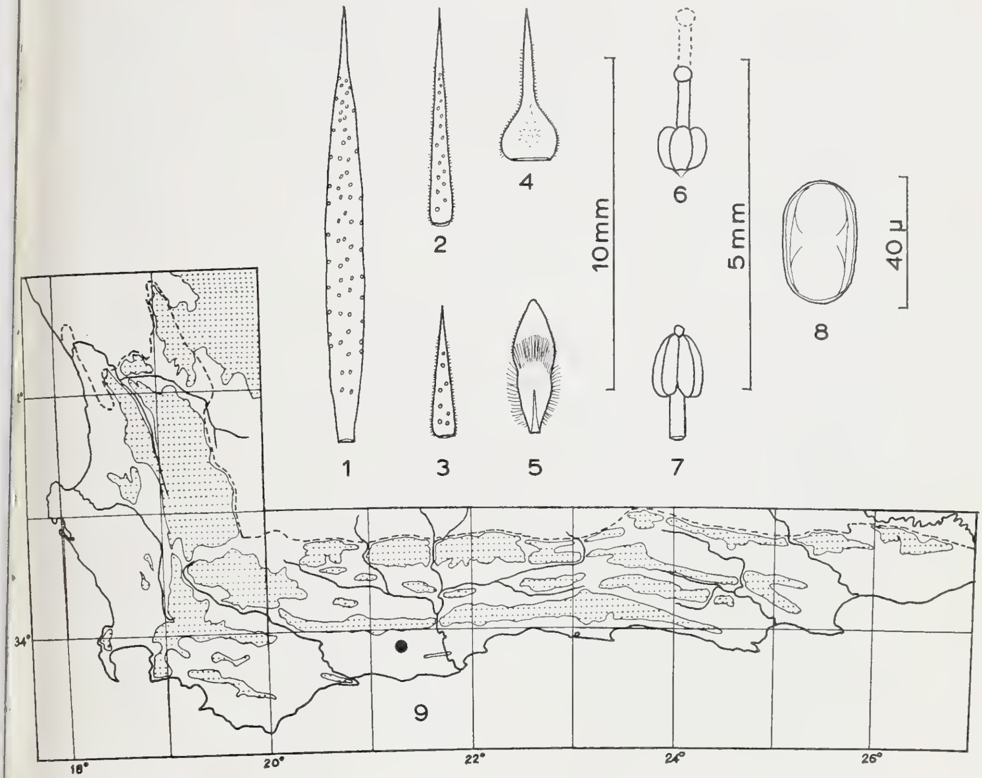

FIG. 2.
Euchaetis longicornis: 1. Leaf; 2. Bract; 3. Bracteole; 4. Calyx lobe; 5. Petal; 6. Gynoecium; 7. Anther; 8. Pollen; 9. Distribution.

Diosma pilosa Williams, sp.nov. as basim monocaulis, propria propter ramulos graciles, folia adpressa, petala numero 2–7 pilos ferentia, discum vinosum, fructum cornibus perbrevibus.

Frutex 30–60 cm, diffusa, ad basim monocaulis. *Rami* erecti, glabri, graciles, dichotomi. *Ramuli* erecti, graciliores, minute scabridi, glanduloso-punctati, foliosi. *Folia* 6–7 mm longa, 1 mm lata, linearia, acuta, callosa, minute ciliolata vel eciliata, glabra, glanduloso-punctata, sessilia, adpressa, erecta, dispersa. *Inflorescentia* reducto-racemosa, terminalis. *Flos* 7 mm diam. *Bractea* 1,8–2,8 mm longa, 0,5–0,8 mm lata anguste lanceolata, acuta, rubro-callosa, minute ciliolata. *Bracteolae* duae, 1,3 mm longae, 0,4 mm latae, lanceolatae, rubro-

callosae, minute serrulatae. *Sepala* quinque, 2 mm longa, 1 mm lata, lanceolata, acuta, marginibus hyalinis sparsim ciliolatis, extus glabra multi-glanduloso-punctata, intus pubescentia. *Petala* quinque, 3,5 mm longa, 1,8 mm lata, ovata, ad basim decrescens, sub-sessilia, marginibus serrulatis sparsim ciliolatis, glanduloso-punctata, in medio numero 2–7 pilis ferens, alba. *Staminodia* fere carens. *Fila* quinque, glabra, vinosa, post anthesin 1,2 mm longa. *Antherae* quinque, ante anthesin 0,8 mm longae, 0,7 mm latae, globosae, vinosae, apicibus minute glandulosis. *Pollen* 48μ longum, 22μ diam., oblongum. *Discus* 5-sinuato-crenulatus, vinosus, apertus, nectarifer, ovarium excedens. *Stigma* 0,2 mm diam., capitellatum, globosum, vinosum. *Stylus* initio deflexus, deinque erectus, 0,8 mm longus, glaber. *Ovarium* 5-carpellatum, 0,6 mm diam., glabrum, vinosum. *Fructus* 5-carpellatus, circa 6 mm longus, 5,5 mm diam., glaber, multi-glanduloso punctata, cornibus perbrevibus. *Semen* 4,5 mm longum, 2,2 mm latum, piceum, nitens.

Type: CAPE—3419 (Caledon): On a shoulder of the Riviersonderend mountains due south of Pilaarkop near Kokrivier (-BB), 460 m alt., 13/4/1974 *Williams 1892* (NBG, holotype; BOL, C, K, MO, M, PRE, S, STE, isotypes).

The first collection of this plant appears to have been made by T. P. Stokoe in April 1930. He found it at an altitude of 1 000 m at Oudebos on the Riviersonderend Mountains. His specimen is preserved in Marloth's herbarium at Stellenbosch.

Shrubs 30–60 cm tall, diffuse, with many slender branches arising from a single stem near the base. *Branches* erect, glabrous, slender, fairly smooth, dichotomous. *Branchlets* erect, very slender, with the pubescence so short that the surface appears to be minutely scabrid, gland-dotted, yellow in colour, well covered by the leaves. *Leaves* 6–7 mm long, 1 mm broad, linear, acute, callused, apex bent slightly inwards, translucent margins at first ciliolate becoming eciliate, glabrous, gland-dotted on both sides, sessile, adpressed, erect, scattered. *Inflorescence* terminal, reduced racemose. *Flowers* opening in succession, 6–7 mm diam., white with a red centre. *Bract* 1,8–2,8 mm long, 0,5–0,8 mm broad, narrowly lanceolate, acute, with a red callus, translucent margins narrow, minutely ciliolate. *Bracteoles* two 1,3 mm long, 0,4 mm broad, lanceolate, acute, red callused, translucent margins minutely serrulate, glabrous except for a few indistinct hairs on the adaxial surface. *Calyx lobes* five, 2 mm long, 1 mm broad, lanceolate, acute, apex inflexed, translucent margins sparsely and minutely ciliolate, outside glabrous, reddened, with many gland dots, inside somewhat pubescent. *Petals* five, 3,5 mm long, 1,8 mm broad, ovate, subsessile, narrowed to the base, white, with gland dots and with from two to seven weak hairs 1,5 mm long near the midrib, margins serrulate with a few minute hairs. *Staminodes* five, virtually absent, a somewhat paler red dot on the disc. *Filaments* five, becoming 1,2 mm long, glabrous, wine coloured, inflexed at first. *Anthers* five, before anthesis 0,8 mm long, 0,7 mm broad, globose, wine coloured, the apical gland becoming sticky at anthesis. *Pollen* ± 49μ long, 22μ diam., oblong. *Disc* 5-sinuate, 5-crenulate at first, becoming less so after anthesis, wine coloured, exudes nectar, exceeds the ovary but stands open. *Stigma* 0,2 mm diam., capitellate, globose, dark red. *Style* at first deflexed, becoming 0,8 mm long, erect, glabrous. *Ovary* 5-capellate, 0,6 mm diam., carpels glabrous, globose, reddened at the apex. *Fruit* 5-carpellate, about 6 mm long, 5,5 mm diam., glabrous, with numerous small gland dots, horns very short with a recessed gland at the apex. *Seed* 4,5 mm long, 2,2 mm broad, black, shining.

Specimens Examined

CAPE—3419 (Caledon): Riviersonderend mountains in kloof (-BB), –/6/1949 *Davis s.n.* (SAM *64119*); Riviersonderend mountains (-BB), –/6/1949 *Stokoe s.n.* (SAM *64125*); Riviersonderend mountains near Zonder Einde (-BB), 14/6/1949 *Wilman 491a* (BOL); foothills of Riviersonderend mountains (-BB), –/4/5–1950 *Lewis 3367* (STE, SAM 64848), 30/4/1950 *Middelmost 1523* (NBG); foothills of Riviersonderend mountains near Neethling's farm (-BB), 30/4/1950 *Wilman 997* (BOL); Riviersonderend mountains, slopes near Riviersonderend (-BB), 2 000–2 500 ft., 5/2/1956 *Esterhuysen 25336* (BOL); Riviersonderend mountains, dry rocky hillside on the west side of the path from Esperance to Pilaarskop (-BB), 7/3/1971 *Esterhuysen 32576* (BOL), 9/4/1971 *Esterhuysen 32592* (BOL); on a shoulder of the Riviersonderend mountains, due south of Pilaarskop near Bokrivier (-BB), 460 m alt., 13/4/1974 *Williams 1892* (NBG, BOL, C, K, M, MO, PRE, S, STE); in dry stony ground, south facing, on the Riviersonderend mountains due south of Pilaarskop near Bokrivier (-BB), 1 600 ft., 13/4/1974 *Williams 1894* (NBG, K, M, MO, PRE, S, STE); Oudebos, Riviersonderend mountains (-BB), 1 000 m, –/4/1930 *Stokoe 2122a* (STE).

Distribution and Biology

Diosma pilosa would appear to be confined to the southern slopes of the Riviersonderend mountains in the vicinity of the village of Riviersonderend. It grows in well drained stony ground derived from the Table Mountain Sandstone at altitudes of from 460 m to 1 000 m above sea level. Having only been collected in bloom from February until June one cannot record the flowering season. Ripe fruits have also been seen in February, April and June, so that one can only say that it has a rather extended flowering period. The presence of nectar in the flowers is a factor which would indicate that this species is insect pollinated and the style at first deflexed, perhaps would indicate that this plant is not self pollinating. Ripe seeds are, as is normal, ejected by a catapult mechanism and regeneration takes place only from seed after fires. The leaves have a very faint smell when crushed.

DISCUSSION

The sub-sessile petals without a transverse beard, standing wide open, revealing the disc and reproductive parts, indicate that it must be placed in the genus *Diosma.*

Diosma pilosa is recognised as a distinct species because it is single-stemmed at the base, has slender branches, adpressed leaves, petals with 2–7 long weak hairs, disc wine coloured and fuits with very short horns. It is nearest in appearance to *Diosma meyeriana* Spreng. (= *D. virgata* B. & W. nom illegit.) but differs in having leaves with gland dots scattered on both sides of the midrib instead of one straight row of gland dots on either side of the midrib, flowers less numerous and much larger with petals bearing 2–7 long weak hairs, calyx lobes with much shorter cilia, and fruits with shorter horns spreading rather than erect. The name is an allusion to the long weak hairs on the petals.

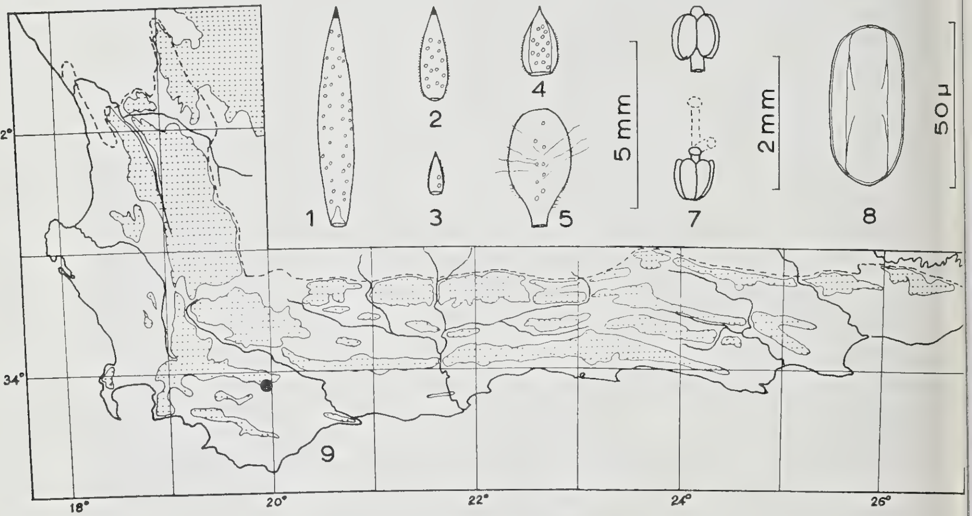

FIG. 3.
Diosma pilosa: 1. Leaf; 2. Bract; 3. Bracteole; 4. Calyx lobe; 5. Petal; 6. Anther; 7. Gynoecium; 8. Pollen; 9. Distribution.

Diosma rourkei Williams, sp.nov. ad basim 25 cm monocaulis, propria propter fruticem usque ad 2 m altum, ramulos fasciculatos, inflorescentiam aggregatam, stylos semper erectos.

Frutex 1–2 m, erectus, ad basim 25 cm monocaulis. *Rami* rigidi, erecti, glabri, asperi. *Ramuli* graciles, minute puberuli, erecti, fasciculati. *Folia* c. 9 mm longa, 1 mm lata, lineari-lanceolata, acuta, mucronata, petiolata, erecto-patens, dispersa, marginibus hyalinis angustis sparsim ciliolatis, costis rotundatis glabris lateribus glanduloso-punctatis, intus minute pubescentibus. *Inflorescentia* terminalis, ad 12 aggregata. *Bractea* 4–5, 5 mm longa, 0,4–0,6 mm lata, subulata, ciliolata, puberula. *Bracteolae* duae, 1,3 mm longae, 0,4 mm latae, lanceolatae, puberulae, ciliatae. *Sepala* quinque, 2–2,3 mm longa, 0,7–0,9 mm lata. oblonga, acuta, glabra, ad basim ciliata, intus pubescentia. *Petala* quinque, 2,8–2,9 mm longa, 1,4–1,6 mm lata, oblonga, glabra, sessiles, alba, recurva, sparsim ciliolata. *Staminodia* quinque, vestigialia. *Fila* quinque, aciculares, glabra, post anthesin 1,5 mm longa, patentes. *Antherae* quinque, ante anthesin 0,9 mm longae, 0,7 mm latae, flavidae. *Pollen* 46μ longum, 25μ latum, oblongum. *Discus* 5 sinuato-crenulatus, viridus, apertus, nectarifer, ovarium excedens. *Stigma* 0,35 mm diam., capitatum, globosum, viridum. *Stylus* 1,3 mm longus, erectus, glaber, persistens. *Ovarium* 5-carpellatum, 0,6 mm diam., glabrum, pallido-viridum. *Fructus* 5-carpellatus, 8 mm longus, 4,5 mm diam., glaber; *pedicellus* 3 mm longus; *cornua* 2,5 mm longa, erecta, pervirida. *Semen* 4,3 mm longum, 1,8 mm latum, piceum, nitens.

Type: CAPE—3324 (Steytlerville): Baviaanskloof, on the Pisgoedvlakte about 2 km from the farm Goedehoop on the road to Willowmore (-CB), 550 m alt., 18/6/1974 *Rourke 1416* (NBG, holotype; Bol, C, GRA, K, M, MO, PRE, S, STE, isotypes).

Very little material relating to this species is to be found in herbaria because it occurs in an area through which the early travellers did not pass and so was not gathered by collectors, such as Drège or Schlechter, who made extensive distributions of their plants. The first recorded gathering was by Fourcade in 1934 who mis-identified it as *Diosma hirsuta* L. However the way in which the leafy branchlets are gathered together into little tufts makes it very easy to recognise as a distinct species even when dried. It was fortunate that Dr. J. P. Rourke, while recently on a collecting trip, was able to obtain an excellent sample of fresh material thus enabling the author to prepare this description.

Shrubs 1–2 m tall, erect, single stemmed for about the first 25 cm above ground. *Branches* stiffly erect, glabrous, becoming rough. *Branchlets* arising in clusters of which only two or three persist after two to four years, slender, erect, minutely puberulous. *Leaves* c. 9 mm long, 1 mm broad, linear-lanceolate, acute, mucronate, petiolate, spreading-erect, scattered, dark green, hyaline margins narrow, sparsely ciliolate, abaxial surface glabrous with a rounded keel prominent when dried, gland dotted on both sides, abaxial surface minutely pubescent up the middle, somewhat convex when fresh becoming quite hollow when dry. *Inflorescence* terminal with the flowers up to 6 mm diam., aggregated into clusters of up to 12, opening in succession. *Pedicel* 1 mm long becoming

longer, glabrous. *Bract* 4–5,5 mm long, 0,4–0,6 mm broad at the base, subulate, ciliolate, puberulous on both sides. *Bracteoles* two, 1,3 mm long, 0,4 mm broad, lanceolate, acute, ciliate, puberulous on both sides. *Calyx lobes* five, 2–2,3 mm long, 0,7–0,9 mm broad at the base, oblong, acute, glabrous, ciliate below, pubescent on the inside, widely spaced. *Petals* five, 2,8–2,8 mm long, 1,4–1,4 mm broad, oblong, glabrous, sessile, recurved, white, apex pseudo-retuse with a small elevated point, margins somewhat irregular with a few short cilia. *Staminodes* five, vestigial, a small gland towards the apex of the lobe. *Filaments* five, glabrous, becoming 1,5 mm long, acicular, spreading after anthesis. *Anthers* five, before anthesis 0,9 mm long, 0,7 mm broad, oblong, yellow with a minute spherical apical gland. *Pollen* 46μ long, 25μ broad, oblong. *Disc* 5-sinuate-crenulate, with the lobes opposite the petals considerably elevated, pale green, stands wide open and free of the ovary, cup fills with nectar. *Stigma* 0,35 mm diam., capitate, globose, green, becoming sticky. *Style* erect, glabrous, becoming 1,3 mm long, persisting. *Ovary* 5-carpellate, 0,6 mm diam., glabrous, pale green, apices of the carpels with a gland surrounded by a few very small bristles. *Fruit* 5-carpellate, 8 mm long, 4,5 mm diam., *pedicel* 3 mm long; *carpels* glabrous, pale green or reddened if exposed, gland dotted on both sides; *horns* about 2,5 mm long, erect, dark green. *Seed* 3,7–4,3 mm long, 1,7–1,8 mm broad, black, shining.

SPECIMENS EXAMINED

CAPE—3324 (Steytlerville): Between Combrinck and Bokkraal, Humansdorp Division (-CB), 2 100 ft., –/10/1934 *Fourcade 5152* (BOL, STE); pass between Cambria and Combrinck, Baviaanskloof, Humansdorp Div. (-CB), 13/4/1952 *Lewis 4143* (SAM), 13/4/1952 *Compton 23475* & *23480* (NBG), 26/4/1953 *Compton 24076* (NBG), 21/10/1955 *Esterhuysen 24990a* (BOL); Baviaanskloof, on the Pisgoedvlakte about 2 km from the farm Goedehoop on road to Willowmore (-CB), 1 800 ft., 18/6/1974 *Rourke 1416* (NBG, BOL, C, GRA, K, M, MO, PRE, S, STE); top of escarpment Baviaanskloof (-CA), 3 000′, 17/4/1973 *Bayliss 6058b* (NBG).

—3323 (Willowmore): Kouga Mt., peak east of Smutsberg, Uniondale Div. (-DB), 27/11/1941 *Esterhuysen 7039* (BOL, NBG); Kouga Mt., lower slopes east of Smutsberg (-DB), 12/11/1944 *Esterhuysen 10723* (BOL); Kouga Mts., between Studtis and Smutsberg, summit slope, Willowmore Div. (-DB), 20/9/1953 *Taylor 902* (NBG).

DISTRIBUTION AND BIOLOGY

From the few collections made it would appear that this plant has a rather small area of distribution. It has been found growing at altitudes of from 550 to 1 500 m (1 800 to about 5 000 feet) above sea level on the Baviaanskloof and Kouga mountains. It appears to be a vigorous plant growing in dense stands to a height of 2 m on soil derived from Table Mountain Sandstone. The flowers, which stand wide open, secrete nectar and are visited by numerous bees and flies amongst which was found a very large bee-like fly with striped eyes. While the pollen is being shed the ovary is minute and the stigma, which at this stage is not sticky of its own accord, is adpressed at the apex of the ovary a long way below the ripe anthers. Some time later, when the pollen has been shed, the style lengthens and the stigma becomes sticky and therefore probably receptive. The flowers would thus appear to be insect pollinated. Flowering and fruiting material have been gathered from April until November so it is possible that this plant could remain in bloom practically the whole year round. The percentage of flowers that actually mature into fruits is very low. One reason for this may be that the centres of many of the flowers are found nibbled out by insects. This is made easier by the wide open petals and is a condition often seen in other species in the genus *Diosma*. Seeds, when ripe, are ejected by the usual catapult mechanism. The plant is single stemmed at base and does not coppice after fires so that regeneration must be entirely by seed. A section from the

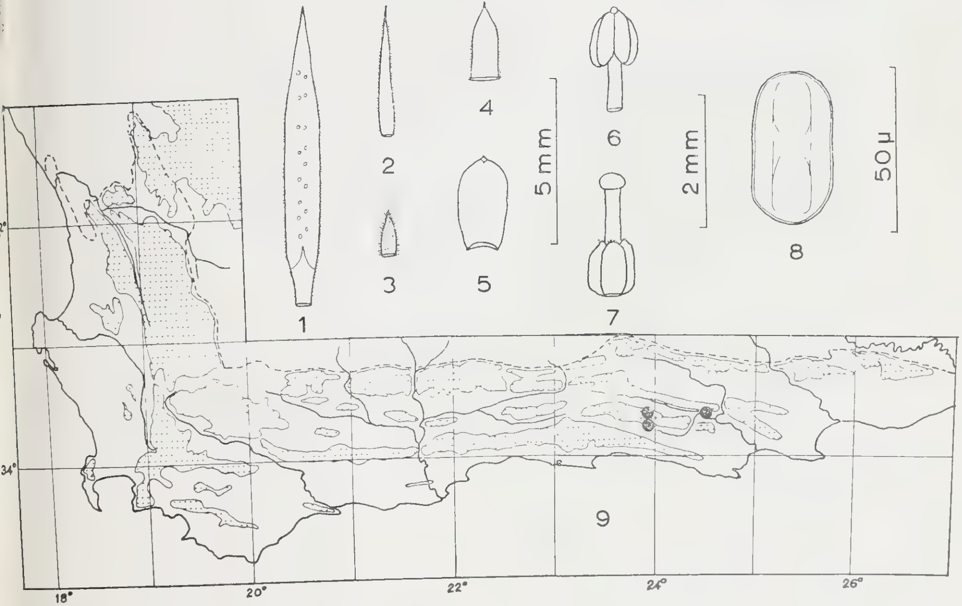

FIG. 4.
Diosma rourkei: 1. Leaf; 2. Bract; 3. Bracteole; 4. Calyx lobe; 5. Petal; 6. Anther; 7. Gynoecium; 8. Pollen; 9. Distribution.

lower part of the stem, about 25 mm diam., shewed about seventeen rings. According to Rourke this particular stand had clearly not been burnt for perhaps twenty years. The leaves have a faint smell of pine needles when crushed.

DISCUSSION

This plant appears, in nearly all respects, to be a typical *Diosma*. (1) The *flowers* are aggregated by reduction into terminal heads. (2) The *petals* are nude and sessile. (3) The *staminodes* are vestigial. (4) The *anther* possesses a minute apical gland. (5) The *disc* is sinuate-crenulate, stands wide open and exceeds the ovary. (6) The *stigma* is capitate. (7) The *style* is short. (8) The *filament* and *style* are glabrous. (9) The *ovary* is 5-carpellate. *D. rourkei* is a distinct species because it is an erect shrub up to 2 m tall, single stemmed for 25 cm at the base, with branchlets crowded into small tufts, the flowers aggregate and the style always erect.

Diosma aristata Williams, sp.nov. ad basim monocaulis, propria propter fruticem praeter apices cornuum glabrum, folia grandiora dispersa patula aristata.

Frutex 70 cm, erectus, ad basim monocaulis. *Rami* dispersi, erecti, glabri, foliis persistens. *Folia* ad 19 mm longa, 2,4 mm lata, subulata, aristata, glabra, glanduloso-punctata, dispersa, patula. *Inflorescentia* reducto-racemosa, terminalis. *Flos* 6 mm diam., pedicellatus. *Bractea* extima 6 mm longa, 1,1 mm lata, similis folio; intima 1 mm longa, 0,6 mm lata, vestigialis. *Bracteolae* duae ad basim calycis, 0,7 mm longae, 0,5 mm latae, lanceolatae, acutae, glabrae, fere vestigiales. *Sepala* quinque, 1,5–1,8 mm longa, 1,2 mm lata, oblonga, apiculata, glabra, plana, marginibus hyalinis serrulatis. *Petala* quinque, 3 mm longa, 1,5 mm lata, oblonga, obtusa, sessiles, alba, patentes. *Staminodia* quinque, 0,1 mm diam., vestigilia. *Fila* quinque, glabra, post anthesin 1,6 mm longa, patentes. *Antherae* quinque, ante anthesin 1,3 mm longae, 0,8 mm latae, oblongae, flavidae. *Pollen* 51μ longum, 24μ diam., oblongum. *Discus* 5-sinuato-crenulatus, viridus, apertus, nectarifer, ovarium excedens. *Stigma* 0,25 mm diam., capitellatum, globosum, viridum. *Stylus* initio deflexus, deinque erectus 1,2 mm longus, glaber. *Ovarium* 5-carpellatum, 0,7 mm longum, 0,8 mm diam., viridum, ad apice minute pilosum. *Fructus* 5-carpellatus, 12 mm longus, pedicellatus, grandulifer. *Cornua* 5 mm longa, patentia, ad apices minute pubescentia. *Semen* 5,5 mm longum, 2,5 mm latum, piceum, nitens.

Type: CAPE—3422 (Mossel Bay): On the north slopes of the hill about 2,5 km east of Mossel Bay near the Reservoir (-AA), 170 m alt., 6/5/1974 *Williams 1902* (NBG, holotype; BOL, C, GRA, K, MO, M, PRE, S, STE, isotypes).

The first person to collect this little known species was William Burchell who gathered his specimen "Near landing place Mossel Bay" on the 28th October 1814. He placed the manuscript name "*Diosma pungens*" on his ticket together with the number 6304 and a brief description which was never published. His herbarium was presented to Kew, too late for it to have been seen by Sonder who had already finished working on the *Diosmeae* for the *Flora Capensis*, published in 1860. From the appearance of the dried material this appeared to be such an unusual plant that it was with great satisfaction that the author was able recently to rediscover it in the vicinity of Mossel Bay.

Shrubs 70 cm tall, erect, well branched, fairly dense, arising from a single stem at ground level. *Branches* scattered, erect, glabrous, ashy coloured, remaining leafy for a long time, not hidden by the leaves. *Leaves* up to 19 mm long, 2,4 mm broad, subulate, acute, with a very sharp point at the apex, margins narrowly translucent with a sharp smooth edge, narrowed slightly at the base to a petiole about 0,5 mm long, glabrous, dark green, triangular in cross-section, gland dotted on both sides of the midrib, scattered, spreading-erect. *Inflorescence* terminal, with up to 5 flowers in a reduced compound raceme; *flowers* about 6 mm diam., pedicellate, the white petals widely spaced with the greenish calyx lobes and disc clearly showing, opening in succession over a long period of time. *Bract* pertaining to the outermost flower 6 mm long, 1,1 mm broad, leaf like; the innermost or upper becoming vestigial, about 1 mm long, 0,6 mm broad, deltoid, glabrous. *Bracteoles* two, placed above the pedicel at the base of the calyx, 0,7 mm long, 0,5 mm broad, lanceolate, acute, glabrous, margins translucent, very minutely serrulate, virtually vestigial. *Calyx lobes* five, 1,5–1,8 mm long, 1,2 mm broad, oblong, apiculate, glabrous, flat, with about 4 gland dots, margins translucent, minutely serrulate. *Petals* five, 3 mm long, 1,5 mm broad oblong, obtuse, sessile, white, spreading widely. *Staminodes* five, vestigial, a minute gland about 0,1 mm diam. towards the apex of the lobe of the disc. *Filaments* five, becoming 1,6 mm long and spreading widely after anthesis, glabrous. *Anthers* five, before anthesis 1,3 mm long, 0,8 mm broad, oblong, yellowish, with a globose sessile apical gland. *Pollen* 51μ long, 24μ diam., oblong. *Disc* 5-sinuate, 5-crenulate, green, exceeds the ovary, stands open forming a cup which fills with nectar. *Stigma* 0,25 mm diam., capitellate, globose, green. *Style* deflexed at first, becoming 1,2 mm long, erect, glabrous. *Ovary* 5-carpellate, 0,7 mm long, 0,8 mm diam., with the carpels minutely bristly around the edges above. *Fruit* 5-carpellate, pedicellate; *carpels* 12 mm long, including the *horn* 5 mm long, glabrous, well endowed with oil glands which readily give off a rather sweet pleasant smell; *horns* spread widely, with apices minutely pubescent. *Seed* 5,5 mm long, 2,5 mm broad, black, shining.

Specimens Examined

CAPE—3422 (Mossel Bay): Near landing place Mossel Bay (-AA), 28/10/1814 *Burchell 6304* (K); Mossel Bay (-AA), –/2/1914 *Moran s.n.* (BOL, SAM *9069*), 7/2/1941 *Walgate 208* (NBG); On the north slopes of the hill about 2,5 km east of Mossel Bay, near the reservoir (-AA), 170 m alt., 6/5/1974 *Williams 1902* (NBG, K, M, MO, PRE, S, STE).

DISTRIBUTION AND BIOLOGY

Diosma aristata would appear to be a fairly rare plant confined to a small area lying to the west of Mossel Bay where its continued existence is now very much in doubt as the whole area is thickly infested with the Australian *Acacia cyclops* introduced to control local drift sand many years ago. It grows in deep sandy soil or, according to Burchell, amongst rocks and would seem to have a very extended flowering period. The nectariferous disc would indicate pollination by insects. Ripe seeds are ejected by the usual catapult mechanism and regeneration most probably takes place after fires. It does not coppice from the root. The leaves give off a pleasant smell rather like that of *Diosma hirsuta* when crushed. A stem 1 cm in diam., showed about 6 annual rings.

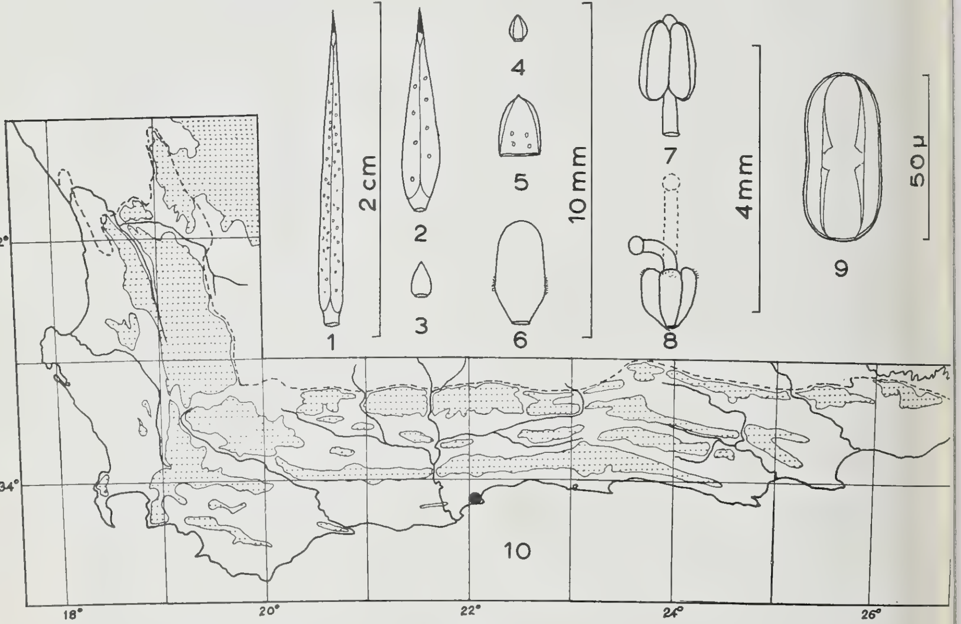

FIG. 5.
Diosma aristata: 1. Leaf; 2. Bract (outermost); 3. Bract (innermost); 4. Bracteole; 5. Calyx lobe; 6. Petal; 7. Anther; 8. Gynoecium; 9. Pollen; 10. Distribution.

DISCUSSION

The following characters show this plant to be a typical *Diosma* (1) *Flowers* solitary in reduced compound racemes. (2) *Petals* nude, sessile. (3) *Staminodes* vestigial. (4) *Anthers* with a minute apical gland. (5) *Disc* sinuate-crenulate, stands open, exceeds ovary. (6) *Stigma* capitellate. (7) *Style* short, at first deflexed. (8) *Filaments* and *style* glabrous. (9) *Ovary* 5-carpellate.

Diosma aristata is recognised as distinct on account of being a plant, arising from a single stem at the ground, with very large aristate scattered leaves, completely glabrous except for the apices of the horns on the fruits. The name alludes to the very sharply pointed leaves.

Macrostylis cauliflora Williams, sp.nov. propria propter fruticem cauliflorum, folia glanduloso-punctata non nisi in costis marginibusque, in omnes partes praeter stigmata parvula.

Frutex 30 cm altus, 50 cm patens, compactus ad basim ramificans monocaulis. *Rami* brevi, numerosi, dichotomi, glabri, asperi. *Ramuli* graciles, numerosi, erectiusculi, foliosi, sparsim puberuli. *Folia* 2–2,5 mm longa, 1,3–1,5 mm lata, elliptica, obtusa, ecallosa, fere eciliata, costis marginibusque glanduloso-punctatis, crassa, glabra, glauca, sessilia, erecta, sparsa. *Inflorescentia* terminalis, pseudo-cauliflora, sessilia, usque ad sex flores aggregata. *Bractea* saepe delapsa, 1,5 mm longa, 1 mm lata, sub-orbicularis, sparsim ciliolata, crassa, glabra, adpressa, costis glanduloso-punctatis. *Bracteolae* duae, 1–1,3 mm longae, 1 mm latae, orbiculares, glabrae, intus concavae, marginibus hyalinis latis membranaceis ciliolatis. *Sepala* quinque, 1,5 mm longa, 1,5 mm lata, orbicularia, glabra, marginibus hyalinis latis membranaceis ciliolatis. *Petala* quinque, 2,8 mm longa, 1 mm lata, obtusa, in medio villosa. *Staminodia* quinque, 0,15 mm longa, globosa, vestigialia. *Fila* quinque, 3,5 mm longa, filiformia, glabra. *Antherae* quinque, ante anthesin 0,6 mm longae, flavae, glandula 0,2 mm diam. coronata. *Pollen* 45μ longum, 21μ diam., oblongum. *Discus* 5-lobatus, viridus, styli basin cingens, nectarifer. *Stigma* 0,3 mm diam., capitellatum, depressum, globosum. *Stylus* 3,6 mm longus, erectus, glaber, crassus. *Ovarium* 3-carpellatum, 0,6 mm longum, 0,7 mm diam., glabrum. *Fructus* 3-carpellatus, cujus unus, duo vel tres maturescunt, ad 11,5 mm longus, *Cornua* 4 mm longa, obtusa. *Semen* 5 mm longum, 2 mm latum, piceum, impolitum.

Type: CAPE—3419 (Caledon): Near the Koude-rivier between Gansbaai and Napier in the Bredasdorp Division (-DA) 76 m alt., 27/2/1974 *Williams 1876* (NBG, holotype; BOL, K, MO, M, PRE, STE, isotypes).

Collected by Harry Bolus in 1895 and by Schlechter in 1896 this plant remained unnoticed until this year when a fresh gathering made by Oliver in 1973 was sent to me for identification. It was apparent to me that it differed from all other known species of *Macrostylis* and its position as a geographical outlier far from any other members of its genus made it even more interesting. Collections, from which this description was prepared, were therefore made in February 1974 and again, in order to obtain fruiting material, in June.

Shrubs up to 25 years old, 30 cm tall, spreading 50 cm, dense, arising from a fairly stout root, branching at ground level. *Branches* short, numerous, dichotomous, glabrous with a rough bark. *Branchlets* very numerous, slender, fairly erect, not very straight, well clothed with leaves, reddish coloured, sparsely puberulous. *Leaves* 2–2,5 mm long, 1,3–1,5 mm broad, elliptic, obtuse without any apical callus or hyaline margins, almost eciliate, glabrous, thick, fleshy, sub-glaucous, gland-dotted on the broad midrib and sometimes minutely so on the margins, sessile, erect, scattered. *Inflorescence* appears to be borne on the older wood at the base of the leafy branchlets, normally at the forking of two branchlets, up to 6-flowered, with flowers 7 mm diam., white, sessile. *Bract* frequently delapsing in the early stages of flowering, 1,5 mm long, 1 mm broad, sub-orbicular, hyaline margin narrow, sparsely ciliolate, thick, glabrous, adpressed, midrib gland-dotted. *Bracteoles* two, 1–1,3 mm long, 1 mm broad, orbicular, obtuse, glabrous, ciliolate, hyaline margins broad and membranous, concave. *Calyx lobes* five, 1,5 mm long, 1,5 mm broad, orbicular, obtuse, glabrous, with a thick green midrib and broad membranous ciliolate margins. *Petals* five, 2,8 mm overall; *limb* about 1 mm diam., obtuse, glabrous, 5–6 gland-dots on the under side; *claw* 1,7 mm long, 0,7 mm broad, narrowing to the base, villous mostly down the midrib, eciliate. *Staminodes* five, 0,15 mm long, globose, vestigial. *Filaments* five, 3,5 mm long, filiform, glabrous. *Anthers* five, before anthesis 0,6 mm long, yellow with a spherical apical gland 0,2 mm diam. *Pollen* 45μ long, 21μ diam., oblong. *Disc* 5-lobed, more or less closes over the ovary, dark green, exudes nectar. *Stigma* 0,3 mm diam., capitellate, depressed globose. *Style* becoming 3,6 mm long, erect, stout, glabrous. *Ovary* 3-carpellate, 0,6 mm long, 0,7 mm diam.; *carpels* broad, retuse, red tipped. *Fruit* 3-carpellate of which one, two or three ripen, glabrous, gland-dotted, reddened, up to 11,5 mm long including the *horn* 4 mm long, obtuse at the apex. *Seed* 5 mm long, 2 mm broad, black, not shining.

SPECIMENS EXAMINED

CAPE—3419 (Caledon): In collibus prope Bredasdorp, Elim (-DB), –/7/1895 *H. Bolus 8477* (BOL, K), 15/7/1895 *Guthrie 3824* (NBG); Elim (-DB), 500 ft., 22/4/1896 *Schlechter 7684* (BM, BOL, K, W,): Koude River east of Baardscheerdersbosch, dry rocky slope above river (-DA), 200 ft., 27/3/1973 *Oliver 4221* (STE); Near the Kouderivier between Gansbaai and Napier in the Bredasdorp Division (-DA), 76 m alt., 27/2/1974 *Williams 1876* (NBG, K, M, MO, PRE, S, STE).

—3420 (Bredasdorp): Bredasdorp mountain. Lower stony, north slopes (-CA), 29/9/1965 *Esterhuysen 31231* (BOL).

Distribution and Biology

Macrostylis cauliflora appears to be confined to a few very small areas of remnant arid scrub in the Bredasdorp Division. At Kouderivier it was observed growing on portions of a dry rocky south facing slope that had escaped the attentions of a bulldozer that had demolished most of the local indigenous vegetation in its search for gravel for the new road. Nearby wherever the ground is level it has been ploughed up for growing crops. It is easy to see that the chances of survival of this relic are rather slim at present. Having been collected in bloom from February until July, it would seem to have an extended flowering period. Ripening fruits were gathered in June (*Williams 1903*) when it was found that this area had recently been heavily grazed off and trampled by sheep. The whole colony was being rapidly exterminated. It is quite possible that, when the number of individuals falls below a certain point, an irreversible process will take place in which recovery will become impossible and this species will become extinct. The ripe seeds are ejected in the normal way by a catapult mechanism. As far as can be seen regeneration takes place only from seed. The leaves, when crushed, are almost without any smell.

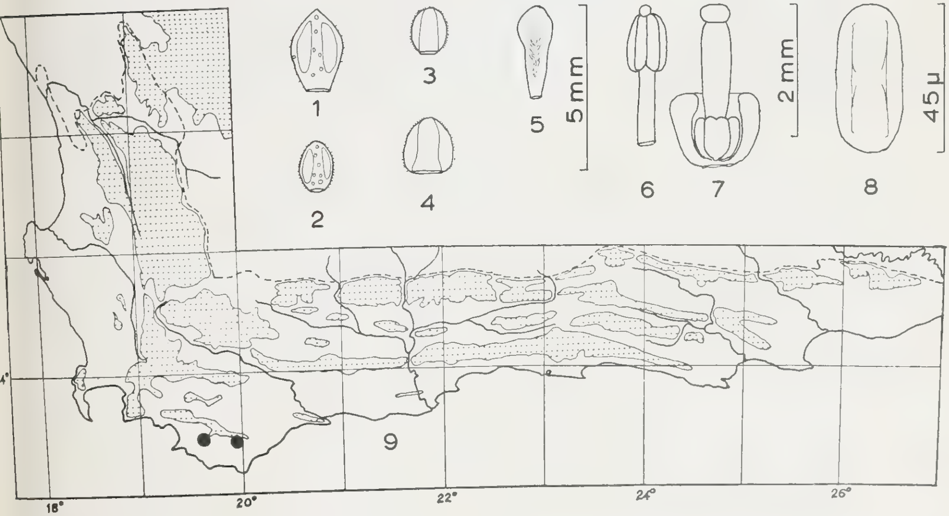

FIG. 6.
Macrostylis cauliflora: 1. Leaf; 2. Bract; 3. Bracteole; 4. Calyx lobe; 5. Petal; 6. Anther; 7. Gynoecium; 8. Pollen; 9. Distribution.

DISCUSSION

This species has been placed in the genus *Macrostylis* Bartl. & Wendl. because each one of the following characters, which it possesses, helps to exclude it from some other genus in the *Diosmeae*. (1) *Heads* multiflorous, up to 6. (2) *Petals* villous, mostly down the midrib. (3) *Staminodes* vestigial. (4) *Anthers* with a minute apical gland. (5) *Disc* encloses the ovary. (6) *Stigma* capitellate, larger than usual in the genus. (7) *Style & filament* long, exceeding the petals. (8) *Style & filament* glabrous. (9) *Ovary* 3-carpellate. (10) *Fruit* with fairly short horns, 2 mm long, which is unusual in the genus.

Macrostylis cauliflora is recognised as distinct on account of being a pseudocauliflorous shrub with leaves gland-dotted only on the midrib and margins, with leaves, petals, style and filaments all smaller than usual and with the stigma rather larger than usual. It is, in appearance, most like *Macrostylis crassifolia* Sond. but differs in that the leaves of *Macrostylis crassifolia* are gland-dotted all over, not only on the midrib and margins. The name is an allusion to the habit of this plant of bearing the flowers below the leafy branchlets.

Jl S. Afr. Bot. 41 (3): 187–198 (1975)

A SURVEY OF THE ANTIMYCOTIC AND ANTIBACTERIAL ACTIVITY OF SOIL MICROFUNGI FROM TRANSVAAL.

Albert Eicker
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Abstract

One hundred and forty-two species of microfungi from a Transvaal soil were examined for the production of antifungal and antibacterial substances. Two methods of assay were used viz. a streak method on agar plates and a liquid culture method.

Antibiotic substances were produced by 74 species (52%). The most significant genera were *Aspergillus*, *Cladosporium*, *Fusarium*, *Penicillium* and *Trichoderma*.

Evidence was found to support the view that the capacity to produce antifungal and antibacterial substances is of ecological significance and that this ability is associated with the dominant fungi in the soil.

Uittreksel

'N ONDERSOEK VAN DIE ANTIFUNGALE- EN ANTIBAKTERIESE-AKTIWITEITE VAN GRONDMIKROFUNGI IN TRANSVAAL.

Een honderd twee-en-veertig mikrofungi van 'n Transvaalse grond is getoets vir die produksie van antifungale- en antibakteriese-stowwe. Twee toetsmetodes is gebruik naamlik uitstryking op agarplate en 'n vloeibare kultuurmedium-tegniek.

Antibiotiese stowwe is deur 74 spesies (52%) gevorm. Die mees opvallende genera was *Aspergillus*, *Cladosporium*, *Fusarium*, *Penicillium* en *Trichoderma*.

Bewys is gevind wat die opvatting ondersteun dat die vermoë om antifungale- en antibakteriese-stowwe voort te bring van ekologiese belang is en dat hierdie vermoë in verband staan met die voorkoms van die dominante fungi in die grond.

Introduction

Many soil inhabiting fungi produce inhibitory substances in laboratory media which antagonize a variety of bacteria, fungi and actinomycetes. Despite the high proportion of soil fungi producing antibiotics in culture, the role of these organisms in the population equilibrium and their significance in determining the composition of the soil microflora is not yet clear. There has been considerable speculation about the ecological significance of antibiotic production by soil-micro-organisms (Brian, 1957; Alexander, 1967). No relationship has yet been given between the predominant species in the soil and their sensivity or resistance to antibiosis. The view that antibiosis does not play a major role in regulating the microbiological equilibrium has been based upon the following facts: that antibiotics never accumulate in the soil, except within the organic substrare; that they have a tendency to be inactivated by absorption

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on colloids and that they are susceptible to biological decomposition (Wright, 1956; Krywolap *et al.*, 1964). None of these factors, however, eliminate the possible micro-ecological significance of antibiosis. Alexander (1967) suggests the following as evidence of the importance of antibiotic-producers in soil:

(a) The abundance of soil species which inhibit the growth of test species;
(b) the greater persistence in soil of indigenous than of alien fungi in the presence of antibiotic-producers;
(c) those *Streptomyces* having the greatest antibiotic potency against certain test fungi in laboratory media generally having the most marked effect on the fungi when tested in sterile soil; and
(d) the formation of antibiotics in normal soil supplemented with one or more per cent organic matter.

Jackson (1965), in his extensive review of the problem of antibiosis and fungistasis of soil micro-organisms, concluded that: "A consideration of all the evidence we now have must convince us that antibiosis, in one form or another, plays a key role in the ecology of soil micro-organisms, being perhaps second in importance only to competition for nutrients."

An ecological investigation of the mycoflora of an alkaline soil of the open-savannah of the Transvaal was conducted during 1971 and 1972. This paper reports on antibiotic production by the isolated soil fungi of the investigated site.

MATERIAL AND METHODS

Soil samples were obtained from an area of undisturbed, natural vegetation within the municipal area of Pretoria. The soil is an alkaline loam soil on which a Sourish Mixed Open-Savannah type vegetation (Acocks, 1953) occurs. The details of the soil analysis, vegetation, collection of soil samples as well as the methods employed for the isolation of the fungi are given elsewhere (Eicker, 1974).

The antifungal and antibacterial properties of the isolated fungi were examined using two methods. The first, a streak method on agar plate cultures (Pridham, 1956), screened all the isolates initially for antagonism. In the second method, the fungi were grown on liquid media and the culture filtrates were assayed periodically for antibiotic activity. The details of these methods are given below.

Streak test for antagonism in agar culture

Petri dishes were prepared containing 15 ml of 2,5% Bacto Antibiotic Medium 2 (Difco Penassay Agar). The medium contained the following:

Bacto-Beef extract 1,5 g; Bacto-Yeast extract 3 g; Bacto-Peptone 6 g; Agar-15 g; distilled water 1 000 ml. The plates were inoculated with a transverse streak of spores of each soil fungus, or with a mycelial transplant in cases where spores were not available. These seeded plates were incubated for 4 days at 25 °C. By means of a platinum loop, 24 hr. old broth cultures of three test bacteria and one test fungus, were then streaked at right angles to the advancing front of the fungus colony. The soil fungi were tested for antagonism to the fungus *Candida albicans* (Robin) Berkhout and the pathogenic bacteria *Staphylococcus aureus* Rosenbach, *Salmonella typhosa* Zopf and *Escherichia coli* Migula. The plates were incubated for a further 24 hr. at 35 °C, after which the degree of antagonism could be assessed in terms of the presence or absence of a clear zone adjacent to the fungus colony.

Antagonism is recorded in Table 1 as follows (Brian & Hemming, 1947):

— = no indication of antagonism,
+ = zone of inhibition not more than 0,5 cm,
++ = zone of inhibition greater than 0,5 cm,
(+) = an apparent decrease in growth of the test organism without production of a clear zone.

Assay of culture filtrates for antagonism

Fungi which proved to be strongly antagonistic in the streak method were tested further. They were grown in 250 ml Erlenmeyer flasks each containing 50 ml of liquid medium comprising a 2% Malt extract (Difco) solution. The flasks were agitated on an orbital shaker at 25 °C for 10 days. The liquid medium was filtered off and assayed for antagonism by the paper disc method (Loo, 1945). Twenty ml of sterile 2,5% Penassay agar per petri dish was allowed to gel before 10 ml of cooled agar seeded with *Bacillus subtilis* Cohn was then poured evenly over the surface. The *B. subtilis* cultures for seeding the agar were grown for 24 hr. at 25 °C on nutrient agar slants and then suspended in 0,83% NaCl solution. The concentration of the suspension was then adjusted with an Unigalvo Type 20 Nephelometer to obtain a uniform density of the bacteria. Three filter paper discs (Whatman Antibiotic Assay discs, 6 mm), previously impregnated with the filtrate of the soil fungus, were placed flat side down on the seeded agar. The cultures were incubated at 25 °C for 22 hr. after which the halos were measured to the nearest 0,1 mm. Only the zone of complete inhibition was considered. The mean values of six inhibiton zones of each fungus tested are given in Table 1.

TABLE 1.
Antibacterial and Antifungal activity of Transvaal Soil Fungi

Accession no.	Organism	Antogonistic effects in agar cultures. (See text for explanation of symbols.)				Antibiotic effect of culture filtrates
		Antibacterial effects			Antifungal effect	*Bacillus subtilis.* (Expressed in mm of zone of inhibition)
	Phycomycetes Zygomycetes	*Staphyllococcus*	*Escherichia*	*Salmonella*	*Candida*	
440	*Absidia cylindrospora* Hagem	+	—	++	—	23,0
478	*Absidia spinosa* Lendner	—	—	(+)	—	*
625	*Mucor fragilis* Bainier	—	—	+	+	
602	*Mucor racemosus* Fres.	—	—	—	(+)	
492	*Mucor spinosus* van Tieghem	+	—	+	+	15,4
331	*Chaetomium globosum* var. *flavoviride* Novak	+	—	—	—	
700	*Chaetomium lusitanicum* Gomes	++	—	—	—	0
433	*Gymnoascus umbrinus* (Boudier) Orr, Kuehn & Pluckitt	++	—	—	(+)	19,6
716	*Nectria invecta* Pethybr.	++	—	—	—	0
	Fungi Imperfecti (Deutoromycetes) Sphaeropsidales					
723	*Coniella diplodiella* (*Speg.*) Petrak & Sydow	+	—	—	—	0
						*Culture filtrates not assayed
502	*Phoma sp.*	—	—	—	(+)	
1059	*Phoma sp.*	+	—	—	++	13,3
790	Unidentified Sphaeropsidales	—	—	—	+	
1040	Unidentified Sphaeropsidales	—	—	++	+	0
	Melanconiales					
313	*Pestalotia sp.*	—	—	—	+	
797	*Pestalotia sp.*	—	—	—	++	21,5
	Moniliaceae					
616	*Aspergillus aculeatus* Iizuka	(+)	—	—	(+)	0
412	*Aspergillus carneus* (Van Tieghem) Blockwitz	++	—	—	(+)	0
445	*Aspergillus* (Bain & Sart.) Thom & Church	++	—	—	+	30,2

Accession no.	Organism	Antogonistic effects in agar cultures. (See text for explanation of symbols.)				Antibiotic effect of culture filtrates
		Antibacterial effects			Anti-fungal effect	*Bacillus subtilis.* (Expressed in mm of zone of inhibition)
	Phycomycetes Zygomycetes	*Staphylococcus*	*Escherichia*	*Salmonella*	*Candida*	
	Moniliaceae (Cont.)					
320	*Aspergillus flavus* (Link) Fr.	++	—	++	+	28,6
338	*Aspergillus fumigatus* Fres.	++	—	—	—	0
509	*Aspergillus nidulans* (Eidam) Wint.	—	—	—	(+)	
528	*Aspergillus ochraceus* Wilhelm	++	+	+	+	27,6
324	*Aspergillus rugulosus* Tom & Raper	+	—	—	++	12,2
516	*Aspergillus ustus* (Bain.) Thom & Church	—	—	(+)	(+)	
342	*Aspergillus versicolor* (Vuill.) Tiraboschi	+	—	—	+	11,0
410	*Aspergillus sp.*	—	—	—	+	
708	*Aspergillus sp.*	+	—	—	—	
468	*Gliocladium* cf. *roseum* Bain. agg.	—	—	(+)	+	0
450	*Paecilomyces sp.*	(+)	+	—	—	0
820	*Paecilomyces sp.*	+	—	—	—	
514	*Penicillium brevicompactum* Dierckx	—	—	—	(+)	
351	*Penicillium chrysogenum* Thom	++	+	+	(+)	17,8
762	*Penicillium crustosum* Thom	+	—	+	—	0
760	*Penicillium cyclopium* Westling	+	++	++	(+)	33,0
609	*Penicillium herquei* Bain. & Sart.	+	—	—	—	
435	*Penicillium lilacinum* Thom	+	—	—	—	
493	*Penicillium multicolor* G.M.—P.	—	—	—	++	0
411	*Penicillium thomii* Maire	+	—	+	—	0
480	*Penicillium waksmanii* Zal.	+	—	—	—	
458	*Penicillium sp.*	++	—	—	—	0
465	*Penicillium sp.*	—	—	—	(+)	
695	*Penicillium sp.*	+	—	+	—	
770	*Penicillium sp.* (Ascosporous) (IMI 161 963)	++	++	++	++	29,2
793	*Penicillium sp.*	—	++	++	—	15,3
1039	*Penicillium sp.*	—	—	++	++	0
1041	*Penicillium sp.*	—	—	++	—	7,3
1085	*Penicillium sp.*	(+)	—	++	(+)	0
1098	*Penicillium sp.*	++	—	—	—	0
1128	*Penicillium sp.*	+	—	—	+	
1168	*Penicillium sp.*	—	—	++	+	15,7
438	*Spicaria violacea* Abbott.	++	—	—	+	18,9
717	*Trichoderma koningii* Oud.	++	++	++	++	26,33
329	*Trichoderma pseudokoningii* Rifai agg.	++	++	++	++	30,00

Accession no.	Organism	Antogonistic effects in agar cultures. (See text for explanation of symbols.)				Antibiotic effect of culture filtrates
		Antibacterial effects			Anti-fungal effect	*Bacillus subtilis.* (Expressed in mm of zone of inhibition)
	Phycomycetes Zygomycetes	*Staphyllococcus*	*Escherichia*	*Salmonella*	*Candida*	
	Moniliaceae (Cont.)					
653	*Trichoderma* cf *pseudokoningii* Rifai agg.	—	—	—	+	
1116	*Trichoderma viride* (Pers.) Gray	++	—	++	++	19,4
1012	*Trichoderma sp.*	++	++	++	++	8,33
1016	*Trichoderma sp.*	++	++	++	++	19,33
1028	*Trichoderma sp.*	+	—	++	++	19,63
1066	*Trichoderma sp.*	++	+	++	—	15,73
1077	*Trichoderma sp.*	—	+	+	++	0
1120	*Trichoderma sp.*	++	—	+	—	0
1130	*Trichoderma sp.*	++	—	—	—	
696	*Verticillium sp.*	+	—	—	—	
1107	*Verticillium sp.*	++	—	—	—	
1119	*Verticillium sp.*	+	+	—	—	
	Dematiaceae					
726	*Alternaria tenuissima* (Kunze ex Pers.) Wiltshire	+	—	+	—	
1027	*Alternaria sp.*	+	—	—	++	0
792	*Cladosporium oxysporum* Berk. & Curt.	—	—	—	+	
1065	*Cladosporium sp.*	+	—	—	+	
1114	*Cladosporium sp.*	+	—	—	—	
1016	*Curvularia sp.*	—	—	—	++	6,9
	Strachybotrys atra Corda	+	—	+	(+)	
475	*Fusarium equiseti* (Corda) Sacc.	—	—	—	+	
418	*Fusarium oxysporum* Schlecht	—	(+)	—	++	0
720	*Fusarium oxysporum* Schlecht	—	—	—	(+)	
745	*Fusarium roseum*	—	—	—	++	
511	*Fusarium sambucinum* Fuckel.	—	—	—	(+)	
456	*Fusarium solani* (Mart.) Sacc.	++	—	—	(+)	19,0
806	*Fusarium solani* (Mart.) Sacc.	—	—	—	+	
759	*Fusarium sp.*	++	—	—	(+)	0
1075	*Fusarium sp.*	—	—	—	+	
	Stilbaceae					
319	*Graphium putredinis* (Corda) Hughes	—	—	—	+	
727	Sterile culture	++	—	—	+	9,0

RESULTS AND DISCUSSION

The ability to produce antifungal substances in the various taxonomic groups of fungi is given in Table 2. Antimycosis was displayed by 2 Zygomycetes, 6 Aspergilli, 2 Cladosporia, 5 Fusaria, 5 Penicillia, 8 Trichodermae and 12 other Fungi Imperfecti. Not one of the Ascomycetes assayed showed any activity against *C. albicans*. The antifungal activity of the *Fusarium* species are of interest. Twelve species were assayed of which 5 showed strong antifungal activity and a further 4 caused less inhibition of the fungal growth. The *Trichoderma* species were particularly active in their antifungal characteristics. Weindling (1941) attributed the antagonistic powers of *Trichoderma* to the secretion of a lethal toxin named gliotoxin. Many strains of *Trichoderma* apparently also produce a powerful antifungal substance viridin (Brian, 1946). Webster and Lomas (1964), however, questioned the production of gliotoxin and viridin by members of this genus. In 1971 Dennis and Webster showed conclusively that these two antibiotics were not produced by *Trichoderma* species, but that chloroform soluble antibiotics, such as trichodermin and certain peptide antibiotics, are formed instead.

Blunt and Baker (1968) found that 35% of the 600 species of fungi isolated from 100 forest and cultivated soils in Hawaii inhibited fungal growth. In this study 142 species of soil microfungi from the open-savannah area were screened for antibiotic activity. Of these fungi, 28,1% (40 species) showed definite antimycotic activity against *Candida albicans*. A further 17 species showed a slight inhibition of growth of the latter fungus.

TABLE 2.

Taxonomic distribution of fungi with antifungal and antibacterial activity

Kinds of fungi	Number of species assayed	Antifungal activity	Percentage	Antibacterial activity*	Percentage
Phycomycetes	13	2	15,4	3	23,1
Ascomycetes	14	0	0	4	28,6
Aspergilli	15	6	40,0	8	53,3
Cladosporia	6	2	33,3	2	33,3
Fusaria	12	5	41,6	2	16,6
Penicillia	24	5	20,8	17	70,8
Trichodermae	11	8	72,7	10	90,9
Other Fungi Imperfecti . .	47	12	25,5	13	27,7
TOTALS	142	40	28,1	59	41,5

* Activity on agar media and in liquid media.

When assayed on agar media for antibacterial activity, 59 species of soil fungi (41,5%) showed positive antagonistic effects towards one or more of the bacteria. Only 9 of the isolates were found to be active against all the test bacteria. From Table 2 it is clear that species of *Trichoderma*, *Penicillium* and *Aspergillus* showed the highest percentage of species antagonistic against the bacterial test organisms.

The production of antibacterial substances by the soil fungi which showed positive results on agar cultures was confirmed in liquid-culture. Forty-nine of these fungal species were grown in liquid medium and culture filtrates were assayed for antibacterial activity. Twenty-eight species showed positive antagonism against *Bacillus subtilis*. It has been suggested that some of the positive antagonistic effects seen in agar culture techniques could be due to local changes in hydrogen ion concentration (Robbins, Kavanagh and Hervey, 1947) and not to true antagonism. Brian (1951) is, however, of the opinion that such false positive results are probably counter-balanced by the tendency of agar antagonism tests to give false negative results when the antibiotic produced is insoluble in water or of high molecular weight.

The only active species of Phycomycetes were *Absidia cylindrospora*, *Mucor fragilis* and *M. spinosus*. Species of these two genera were also the only active Phycomycetes from soils of Surrey and Dorset (Jeffreys *et al*, 1953). In the Ascomycetes *Chaetomium globosum* var. *flavo-viride*, *C. lusitanicum*, *Gymnoascus umbrinus* and *Nectria invecta* showed definite antagnositic activity against test bacteria. Culture filtrates of *G. umbrinus* showed marked inhibition of *Bacillus subtilis*. Karow and Foster (1944) found species of this genus to be active producers of the antibiotic patulin. *Chaetomium* species are known to produce antibiotics (Waksman & Bugie, 1944).

Members of the genus *Aspergillus* have been extensively studied and most known species have been screened for antibiotic production, (Gill-Cary, 1949). Of the 15 Aspergilli assayed, only *Aspergillus niger*, *A. sydowii* and *A. wentii* were inactive. The most active species were *A. flaviceps*, *A. flavus*, *A. ochraceus*, *A. rugulosus* and *A. versicolor*, all of which are well known antibiotic producers (Raper & Fennell, 1965).

Species of *Gliocladium* are known to produce a variety of antibiotics (Brian, 1951). None of the species tested in this investigation were active. *Paecilomyces* species were also not active. *Penicillium chrysogenum*, *P. cyclopium*, *Penicillium sp.* (770), *P. sp.* (793), *P. sp.* (1041) and *P. sp.* (1168) were very active, showing antagonistic effects both on agar medium and in liquid culture. The outstanding fungus of this survey is certainly the ascosporous *Penicillium sp.* (770) which not only showed exceptional antibacterial activity, but also markedly inhibited growth of *Candida albicans*. Only four *Penicillium* species were inactive. The genus *Penicillium* is well known as a potential source of antibiotic substances and the members of this genus have been assayed for antibiotics extensively (Brian, 1951; Raper & Thom, 1949).

It has been pointed out (Table 2) that species of *Trichoderma* were exceptionally antagonistic towards bacteria. The outstanding species here are *T. koningii*, *T. pseudokoningii*, *T. viride* and the unidentified species 1016, 1028 and 1066. The Dematiaceae family as a whole was not active. Species of the genera *Alternaria*, *Cladosporium*, *Curvularia* and *Stachybotrys* showed some antagonistic activity. *Stachybotrys atra* is known to produce antibiotics (Robbins, 1945). Of the rest of the Fungi Imperfecti, certain species of *Fusarium* and *Rhizoctona solani* showed some activity but *Fusarium solani* was the only species with marked antibacterial activity.

TABLE 3.

Percentage of abundant, common and rare species of soil fungi producing antibacterial and antifungal activity. (Abundant species—relative frequency more than 10%; common species = relative frequency 1–10%; rare species = relative frequency = less than 1%; Eicker, 1974.)

Fungus Species	Antibacterial activity	Antifungal activity
Abundant species		
Mucor spinosus	+	+
Chaetomium globosum	—	—
Aspergillus rugulosus	+	+
Cliocladium roseum	—	—
Penicillium multicolor	—	+
Spicaria violaceae	+	+
Trichoderma viride	+	+
Fusarium species (all species)	+	+
8 Species	63% active	75% active
Common species	+	—
Absidia cylindrospora	—	—
Cunninghamella echinulata	—	+
Mucor racemosus	—	—
Zygorhynchus moelleri	—	—
Chaetomium spinosum	—	—
Gymnoascus umbrinus	+	—
Pleospora infectoria	—	—
Coniella diplodiella	+	—

Fungus species	Antibacterial activity	Antifungal activity
Aspergillus carneus	+	—
A. flavus	+	+
A. fumigatus	+	—
A. versicolor	+	+
Paecilomyces sp. (450)	+	—
Paecilomyces sp. (820)	+	—
Penicillium chrysogenum	+	—
P. cyclopium	+	—
P. frequentans	—	—
P. rainstrickii	—	—
P. waksmanii	+	—
Scopulariopsis brevicaulis	—	—
Trichoderma pseudokoningii	+	+
Alternaria tenuissima	+	—
Cladosporium tenuissima	—	—
Gonytrichum macrocladum	—	—
Humicola sp. 309	—	—
Stachybotrys atra	+	—
Epicoccum purpurascens	—	—
Doratomyces stemonites	—	—
28 Species	44% active	14%
Rare fungi		
106 species	36% active	25% active

There appears to be a correlation between the capacity of a fungus to produce antibacterial and antifungal substances and its relative frequency of occurrence in the soil. Of the eight fungi most abundant in samples of the alkaline Transvaal soil 63% produced antibacterial substances and 75% produced antifungal substances (Table 3). In comparison, 44% of the common fungi (relative frequency 1–10%) produced antibacterial substances while only 14% of these fungi showed antifungal activity. The figures for the rare fungi are 36% and 25% for antibacterial and antifungal activity respectively. In spite of their abundance, certain fungi, such as *Chaetomium globosum* and *Gliocladium roseum* did not produce any antifungal or antibacterial antibiotics. *Penicillium multicolor*, also abundant, produced antifungal substances but showed no antibacterial activity. Previous investigations show that many of the widespread, non-producers of antibiotics are relatively resistant to antibiotics produced by other species (Jeffreys *et al* 1953; Dix, 1972) and this characteristic gives them a strong competitive ability.

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EMBRIOGENIE VAN *MELIANTHUS MAJOR* L.

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Uittreksel

Melianthus major stem embriogeneties ooreen met die Penaea-variasie van die Asterad-tipe. 'n Suspensor ontbreek by die embrio en 'n epifise-inisiaalsel word gevorm. Die basale sel van die tweesellige pro-embrio ondergaan herhaaldelike lengtedelings voordat dwarsdelings plaasvind.

Abstract

EMBRYOGENY OF *MELIANTHUS MAJOR* L.

Melianthus major conforms to the Penaea variation of the Asterad type embryogenetically. The embryo lacks a suspensor and an epiphysis initial is formed. Longitudinal divisions occur in the basal cell of the bicellular pro-embryo, before the cells are segmented transversely.

Inleiding

Die embriogenie van die families wat deur Scholz (1964) onder die Sapindales geplaas is, is tot dusver swak bekend. Slegs enkele genera onder die Anacardiaceae, Aceraceae, Sapindaceae en Balsamineaceae is embriogeneties ondersoek (Johansen, 1950 en Davis, 1966). Die embriogenie van die Melianthaceae en Greyiaceae is dus nog onbekend. Die Melianthaceae word in Suid-Afrika verteenwoordig deur die genera *Melianthus* L. en *Bersama* Fresen. terwyl die Greyiaceae slegs deur die endemiese genus *Greyia* Hook & Harv. verteenwoordig word.

Die Melianthaceae en Greyiaceae is volgens verskeie taksonome naverwant (Lawrence, 1963; Scholz, 1964 en Takhtajan, 1969), maar Johansen (1950) erken in sy oorsig oor die embriogenie van die Spermatophyta nie hierdie verwantskap nie. Hy plaas die Melianthaceae onder die orde Sapindales, maar die Greyiaceae saam met die Cunoniaceae, Brunelliaceae, Escalloniaceae en Hydrangeaceae onder die orde Cunoniales. Ook hierdie families is embriogeneties nie ondersoek nie.

By die ondersoekte taksa ressorteer die embrio's volgens Johansen (1950) en Davis (1966) òf onder die Asterad-tipe (*Anacardium*, *Hydrocera*, *Cardiospermum* en *Impatiens*) òf onder die Onagrad-tipe (*Acer*, *Semecarpus*, *Lannea* en *Rhus*). Davis (1966) meld nie die variasie binne die embrio-tipe nie; tereg beweer sy

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dat die taksonomiese belangrikheid van die onderverdeling van Johansen se hooftipes nog twyfelagtig is weens gebrek aan beskikbare literatuur.

Aangesien die Onagrad- en Asterad-tipes baie algemeen onder die Dicotyledoneae voorkom (dit kom volgens Davis (1966) in 81 van die 179 ondersoekte families voor) kan 'n kritiese waardering van die taksonomiese waarde van die variasies binne hierdie twee naverwante hoof-embriotipes moontlik 'n belangrike bydrae tot die taksonomie lewer.

In 'n poging om van die ontbrekende data met gegewens van twee Suid-Afrikaans-verteenwoordigende families aan te vul, is geskikte verteenwoordigers van al drie genera, nl. *Melianthus*, *Bersama* en *Greyia* ondersoek. Resultate oor laasgenoemde twee taksa sal later bespreek word.

MATERIAAL EN METODES

Volwasse saadknoppe en sade van *Melianthus major* L. is in die veld versamel en gefikseer in 6% glutaraldehied by 0 °C in 'n 0,025 M. fosfaatbufferoplossing met pH 6.8 (Feder en O'Brien, 1968). Om doeltreffende indringing van die fikseermiddel te verseker, is die chalazale gedeeltes van die saadknoppe en sade verwyder. Die materiaal is volgens die metode van Feder en O'Brien (1968) by 0 °C gedehidreer, tot kamertemperatuur gebring en geïmpregneer met en ingebed in 'n mengsel van glikolmetakrilaat (Ashley en Feder, 1966). Ultramikrotoom-seriesneë van 3 μm is gekleur met "Periodic Acid"—Schiff se reagens (PAS) en toluïdienblou (Feder en O'Brien, 1968).

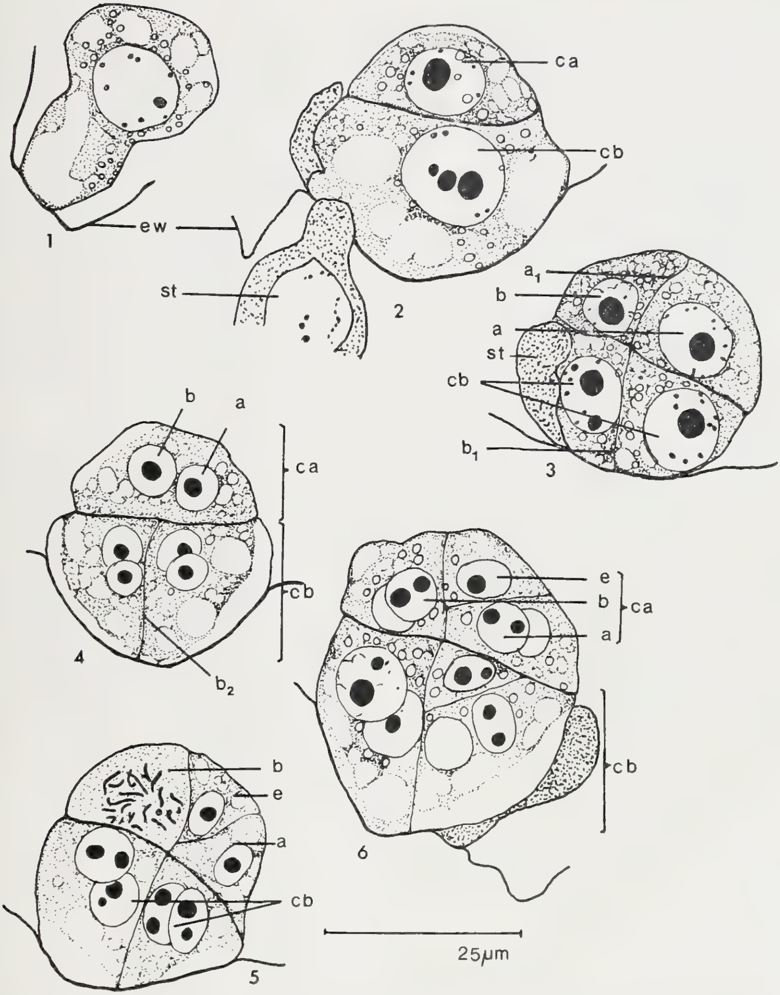
Soortgelyke materiaal van *Melianthus pectinatus* Harv. is in die veld in F.A.A. gefikseer en gebruik vir verhelderingstudies van die embrio (Smith, 1973).

Alle tekeninge is met behulp van 'n Leitz Wetzlar-tekenbuis gedoen. In seriesneë van sommige embrio's was al die kerne nie in dieselfde snee sigbaar nie en is agtereenvolgende sneë oormekaar geprojekteer om die kerne in die regte posisies in te teken.

ONDERSOEK

Die sigoot is peervormig (Fig. 1) tot ovaalvormig met die kern in die breë apikale deel van die sel geleë, ingebed in sitoplasma en omring deur vakuoles. Die basale deel van die sel is meer gevakuoleerd. Klein, ronde tot ovaalvormige liggaampies wat met "Periodic Acid"—Schiff se reagens ligrooi kleur maar geen ander positiewe setmeelreaksie gee nie, is aanwesig in die sitoplasma van die sigoot en die selle van die embrio. Die stuifmeelbuis bly lank na bevrugting sigbaar (Fige. 2, 3 en 6) maar die sinergied-reste verdwyn net na bevrugting.

Die sigoot (Fig. 1) deel dwars om die selle van die eerste selgenerasie, nl. die terminale sel (ca) en die basale sel (cb) te vorm (Fig. 2). In 'n lengtesnee is die terminale sel kenmerkend klein, sitoplasmaryk en lensvormig, terwyl die basale sel groter en meer gevakuoleerd is.



FIGS. 1–6

Mediane lengtesneë deur die ontwikkelende embrio van *Melianthus major* L.: fig. 1, die sigoot; fig. 2, dogterselle van die sigoot; fig. 3, globulêre tetrade; fig. 4, sessellige pro-embrio; fig. 5, ontstaan van die epifise-inisiaalsel gedurende die derde selgenerasie; fig. 6, vorming van die vierde selgenerasie; a, dogtersel van die terminale sel; a_1, eerste lengtewand in die terminale sellaag; b, dogtersel van die terminale sel; b_1, eerste lengtewand in die basale sellaag; b_2, tweede lengtewand in die basale sellaag; ca, terminale sel; cb, basale sel; e, epifise-inisiaalsel; ew, embriosakwand; st, stuifmeelbuis.

Die eerste deling van die basale sel is oorlangs, soos die eerste deling van die terminale sel (Fig. 3). Die twee lengtewande (a_1 en b_1 in Fig. 3) is dus loodreg op die eerste delingswand van die sigoot en parallel aan mekaar. Die vier selle van die tweede selgenerasie lê dus in twee lae van twee selle elk, maar in dieselfde vertikale vlak.

Hierdie tipe van globulêre tetrade is volgens Crété (1963) kenmerkend van meer primitiewe embrio's, naamlik die pro-architipes van Souéges. Johansen (1950) meld dat hierdie tetrades normaalweg onder die Pteridophyta-embrio's voorkom, maar skaars is onder Angiospermae en dat hulle oorsprong gee aan onreëlmatige of spiralige embrio's. Maheshwari (1950) meld nie hierdie tipe tetrade in sy bespreking van die embrio-ontwikkeling van Angiospermae nie.

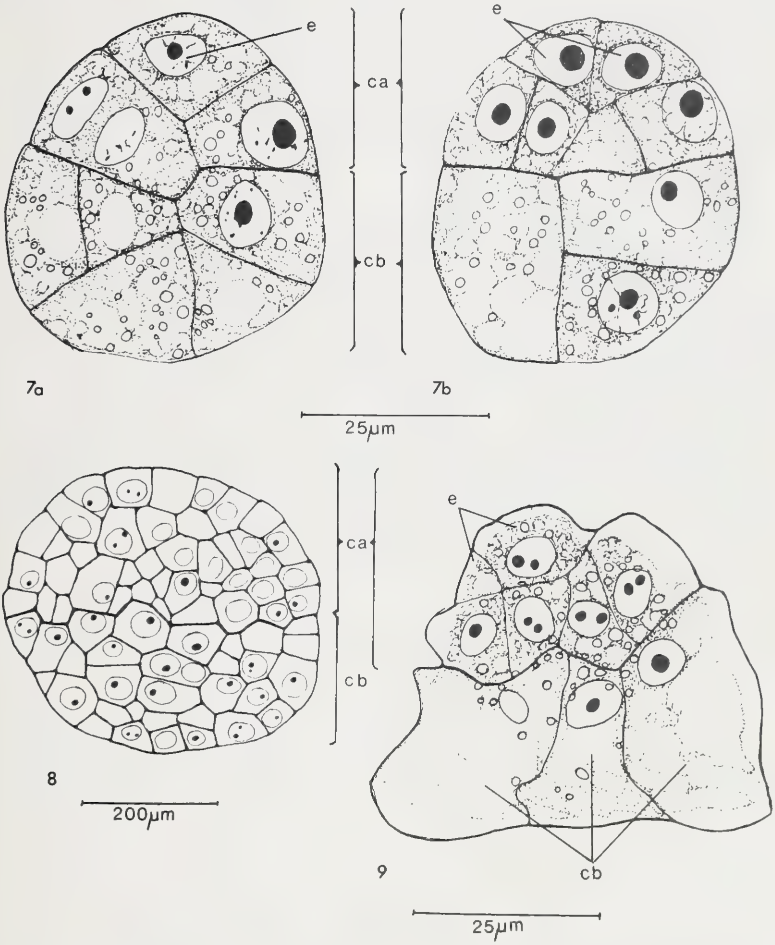
Gedurende die verdeling van die twee dogterselle van die basale sel word weer eens lengtewande neergelê, maar reghoekig op die eerste (b2 in Fig. 4), sodat die selle van die derde selgenerasie in die basale sellaag in dieselfde horisontale vlak lê.

Die twee opeenvolgende lengtedelings in plaas van dwarsdelings van die basale sel veroorsaak dat geen tipiese hipofise-inisiaalsel (Crété, 1963) gevorm word nie. Weliswaar word 'n klein hoekige sel, wat moontlik met 'n hipofise-inisiaalsel verwar kan word, in sommige gevalle in die vierde selgenerasie gevorm (Fig. 6), maar dit is nie 'n konstante kenmerk van die embrio nie. Na die vorming van die selle van die derde selgenerasie deel die derivate van die basale sel onreëlmatig (Fige. 7a en 7b) deur middel van skuins, lengte- en dwarswande. Die klein hoekige sel is waarskynlik maar die gevolg van die onreëlmatige delings.

Moontlik is hierdie lengtedelings van die basale sel ook verantwoordelik vir die afwesigheid van 'n suspensor by die embrio van *Melianthus major*. Verhelderingstudies van die sade van *Melianthus pectinatus* het getoon dat 'n suspensor ook in hierdie spesies afwesig is. Die afwesigheid van 'n suspensor by die embrio is dus waarskynlik 'n konstante generiese kenmerk.

Skynbaar is 'n suspensor nie noodsaaklik vir die ontwikkeling van die embrio van *Melianthus* nie en dit word moontlik reeds op hierdie vroeë ontwikkelingstadium uitgeskakel in ooreenstemming met die mees fundamentele embriologiese wet wat konstateer: "No more cells are produced by the embryo than are absolutely necessary" (Johansen, 1950). Weliswaar is embrioloë onseker oor die funksie van die suspensor (Crété, 1963) behalwe vir die feit dat dit die embrio moontlik in die voedende endospermweefsel in forseer (Maheshwari, 1950). Is die suspensor dalk 'n reliek van die Gymnospermae-embrio waar die struktuur goed ontwikkeld en funksionerend is?

Gedurende die ontstaan van die derde selgenerasie deel een (a in Fig. 3) van die dogterselle van die terminale sel skuins sodat 'n kleiner wigvormige sel, die epifise-inisiaalsel (e in Fige. 5 en 6) en 'n groter, onderste sel (a in Fige. 5 en 6) gevorm word. Die tweede dogtersel (b in Fige. 3 en 5) van die apikale sel deel



FIGS. 7–9

Mediane lengtesneë deur die ontwikkelende embrio van *Melianthus major* L.: fige. 7a en b, opeenvolgende sneë van die embrio om die derivate van die epifise-inisiaalsel te toon; fig. 8, ouer embrio voor die anlage van die saadlobbe om die afwesigheid van 'n suspensor te toon; fig. 9, abnormale embrio; ca, derivate van die terminale sel; cb, derivate van die basale sel; e, derivate van epifise-inisiaalsel.

oorlangs, reghoekig op die eerste lengtedeling van die apikale sel en parallel aan die tweede lengtedeling in die basale sellaag. Die selle van die derde selgenerasie in die apikale sellaag lê dus nie in dieselfde horisontale vlak nie, omdat die epifise-inisiaalsel bokant sy sustersel lê (Fige. 5 en 6).

Die optrede van 'n epifise-inisiaalsel is reeds in 1923 deur Souéges by die embrio van *Geum urbanum* aangetoon en kom in diverse embrio-tipes voor (Johansen, 1950). Uit hierdie sel en sy derivate ontstaan die stingelgroeipunt (Crété, 1963).

Die derivate van die terminale sel deel oorlangs gedurende die vorming van die vierde en vyfde selgenerasies (Fige. 6, 7a en 7b), sodat drie selle (derivate van die epifise-inisiaalsel) in die apikale sellaag en ses selle (derivate van die dogtersel b van die terminale sel en die sustersel a van die epifise-inisiaalsel in Fig. 5) in die tweede sellaag aanwesig is. Deur verdere delings van die embrionale selle ontstaan 'n ronde embrio waarvan die boonste gedeelte afkomstig is van die terminale sel en die onderste gedeelte van die basale sel (Fig. 8).

In sommige gevalle is die embrio nie rond nie, maar wissel van halfmaanvormig tot ovaalvormig wat as abnormaal beskou word en waarskynlik te wyte is aan vertraagde delings in die derivate van die basale sel: in jonger sade is hierdie selle abnormaal groot en gevakuoleerd (Fig. 9). Hierdie abnormale embrio's kan een van die oorsake wees waarom so baie sade van die ondersoekte plante op 'n relatief laat stadium aborteer.

BESPREKING

Die embrio van *Melianthus major* ressorteer volgens sy patroon van ontwikkeling onder die Asterad-tipe van Johansen, aangesien die terminale sel van die tweesellige pro-embrio oorlangs deel en beide die terminale en basale selle bydra tot die vorming van die ware embrio.

Weens die afwesigheid van 'n suspensor wat Johansen (1950) as die belangrikste onderskeidende kenmerk in sy bepaling van die variasies binne die Asterad-tipe beskou, word die embrio van *Melianthus major* verder onder die Penaea-variasie geplaas. Slegs by een van die ondersoekte taksa nl. *Anacardium occidentale* (Anacardiaceae) ressorteer die embrio onder hierdie variasie (Johansen, 1950).

Die aanwesigheid van 'n epifise-inisiaalsel wat 'n opvallende kenmerk van die ontwikkelende *Melianthus*-embrio is, is ook taksonomies belangrik om tussen die variasies binne die Asterad-tipe te onderskei. Dit kom voor by *Impatiens balfouri* (Souéges, 1945 volgens Johansen, 1950) en *Hydrocera triflora* (Venkateswarlu en Lakshminarayana, 1957) van die Balsaminaceae. Eersgenoemde spesies ressorteer onder die Geum-variasie en laasgenoemde onder die Erodium-variasie. By *Acer* (Aceraceae) en *Semecarpus anacardium* (Johansen, 1950) van die Anacardiaceae tree 'n epifise-inisiaalsel ook op, maar hierdie twee taksa word onder die Trifolium-variasie van die Onagrad-tipe geplaas, wat volgens Johansen (1950) moontlik onder die Asterad-tipe ingesluit behoort te word, aangesien 'n epifise-inisiaalsel meer kenmerkend van laasgenoemde embrio-tipe is.

Die besondere delingspatroon wat die basale sel van die *Melianthus*-embrio volg deur lengte- in plaas van dwarsdelings te ondergaan, moet, totdat meer soortgelyke gevalle in die literatuur vermeld word, as 'n besondere en waarskynlik primitiewe kenmerk van die *Melianthus*-embrio beskou word. Dié lengtedelings verhoed waarskynlik die vorming van 'n hipofise-inisiaalsel en 'n suspensor.

Dit sou voorbarig wees om op grond van die karige literatuur oor hierdie aspek van die embriologie te beweer dat die Sapindales kenmerkend 'n Asterad-tipe embrio vertoon, hoewel die beskikbare literatuur daarop dui. Indien dit die geval is, is hierdie betreklike klein orde 'n geskikte navorsingsveld vir die bepaling van die taksonomiese waarde van die variasies binne een van die mees algemene embrio-tipes wat onder die Angiospermae aangetref word. Daardeur mag die embriologie 'n belangrike bydrae tot die taksonomie lewer.

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My opregte dank aan die volgende instansies en persone: Die W.N.N.R. vir die beskikbaarstelling van 'n doktorale beurs en addisionele fondse; die Universiteit van Pretoria vir finansiële steun en prof. dr. H. P. van der Schijff en prof. dr. P. J. Robbertse van die Departement Algemene Plantkunde, Universiteit van Pretoria, vir hulle gewaardeerde belangstelling, hulp en leiding gedurende hierdie studie.

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A NEW SPECIES OF *PROTEA* IN THE TRANSVAAL

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Abstract

A new species of *Protea*, *P. laetans* from the Eastern Transvaal is described and illustrated.

Uittreksel

'N NUWE *PROTEA*-SOORT IN TRANSVAAL

'n Nuwe *Protea*-soort, *P. laetans* wat in die Oos-Transvaal voorkom word beskryf en geïllustreer.

Protea laetans L. E. Davidson, sp. nov. A speciebus affinibus, stipite longo crasso lignoso, bracteis involucralibus perpetuo velutinis, florescentia praecipue autumnali, optime distinguiter.

Arbor tenuis ad 5 m alta. Truncus brevis ad 20 cm diametro. Rami longi adscendentes, foliis distalibus. Cortex griseus in rectangulis fissuratus. Rami juveniles rosei flavescentes, mox grisei, glabri, lenticellis albis multis longitudinaliter marmorati. Gemma vegetativa bracteis parvis pubescentibus argenteis imbricatis. *Folia* sessilia 14-19 cm longa 1,5-3,0 cm lata falcatiuscula linearia-oblanceolata, apice acuto vel rotundatiusculo; lamina coriacea glabra glauca, margine translucenti flavescenti; costa basi 3 mm lata utrinque conspicua, plerumque rubra ab immo flavescens ad summum, gradatim decrescens ad apicem evanescens; folia basi 90° torta, laminis obliquis, faciem characteristicam producentia. *Inflorescentia* stipitata superne cyathiformis 8-10 cm longa stylis inclusis, 8-10 cm lata, post anthesin conica; stipes lignosus 1,5-2,5 cm longus 1,5-2,0 cm latus; receptaculum planum. *Bracteae* 14-17 seriatae carminae ciliatae pubescentes, saepe in margine glabrae; pubescentia argentea vel ferruginea, plerumque argentea cum area media ferruginea; bracteae intimae 4,5 cm longae (0,5) 1,0-1,5 cm latae concavae oblongae vel obovatae, apice rotundato; bracteae seriei secundae 3,5-4,0 cm longae 1,5-2,0 cm latae ovatae; ceterae late ovatae basim versus decrescens. *Perianthium* 5-6 cm longum, basi albidum, apicem versus rubescens; pagina externa 1,5–2,0 cm basi glabra, tum inter nervos et ad marginem pilis vel pilis sparsis, labium 1,5–1,8 cm longum, pubescentia ferruginea densa; pagina interna 1,5–2,0 cm basi glabra, tum pilis marginalibus, et pilis densis basi antherarum, glabra superne; segmentum

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anticum 5 mm latum ad 1 mm decrescens; pars postica (segmenta 2 lateralia 1 posticum conjuncta) 10 mm lata ad 2 mm decrescens. *Antherae* 4 subsessiles 1 cm longae, anthera postica minime breviore; umbo apicalis sagittatus in quoque anthera. *Stylus* ad 5 cm longus, basi 2 mm latus albidus, apicem versus decrescens rubescens et minime geniculatus; pars pollen praebens (stigma inclusa) 1 cm longa filiformis carnea albescens, stylo valde similis, longistrorsum sulcata, apice rotundato. *Fructus* 11 mm longus 4 mm latus, basi ad 2 mm contractus, pilis longis ferrugineis. *Squamae hypogynae* 4 ovatae 1 mm longae.

Slender tree up to 5 m high. *Trunk* short up to 20 cm across with long ascending branches distally leafy. Fire damage causing branching at or near ground level; bark grey splitting into rectangles. *Young branches* pink to yellow soon turning grey, glabrous with longitudinal patterning of abundant white lenticels. *Vegetative bud* with small densely packed silvery pubescent bracts. *Leaves* sessile 14-19 cm long, 1,5-3,0 cm wide, slightly falcate, linear-oblanceolate, apex acute to slightly rounded; blade leathery, glabrous, grey-green with pale yellow translucent margin; midvein 3 mm wide usually red at base, shading to yellow tapering and disappearing towards leaf apex, conspicuous on both surfaces; blade base twisted through 90° so that leaves are oblique; shape and angle of leaf giving characteristic appearance to tree. *Inflorescence* stipitate, cyathiform above, at anthesis shallowly cyathiform, 8-10 cm long including styles, 8-10 cm across, after anthesis closing to conical; stipe woody, 1,5-2,5 cm long, 1,5-2,0 cm across; receptacle flat. *Bracts* 14-17 seriate, carmine, ciliate, pubescent often with glabrous marginal band, pubescence silvery to ferruginous, usually silver with median area ferruginous; innermost bracts 4,5 cm long, (0,5) 1,0-1,5 cm wide, concave, oblong to obovate, apex rounded; next row 3,5-4,0 cm long, 1,5-2,0 cm wide, ovate, thereafter becoming broadly ovate, decreasing in size towards base. *Perianth* 5,0-6,0 cm long, ivory white at base shading to pink; outer surface glabrous for 1,5-2,0 cm at base becoming sparsely hairy to hairy between veins and on margins, lip 1,5-1,8 cm long with dense ferruginous pubescence; inner surface glabrous for 1,5-2,0 cm at base becoming hairy on margins and densely hairy at base of anthers, glabrous above; single anticous perianth segment 5 mm wide tapering to 1 mm; posticous portion (3 joined segments, 1 posticous, 2 lateral) 10 mm wide tapering to 2 mm. *Anthers* 4, subsessile, 1,0 cm long each with sagittate apical boss, posticous anther fractionally shorter. *Style* up to 5,0 cm long, at base 2 mm across, white, shading to red, tapering, minutely geniculate near apex; pollen presenter (including stigma) 1,0 cm long filiform, scarcely differentiated from style, pale pink to white, longitudinally grooved, rounded at apex. *Fruit* 11 mm long 4 mm wide, tapering to 2 mm at base, covered with long ferruginous hairs. *Hypogynous scales* 4, ovate 1 mm long.

Diagnostic characters: This species is distinguished from related species by its long, stout woody stipe, permanent velutinous pubescence on outer surface of involucral bracts and autumnal flowering peak.

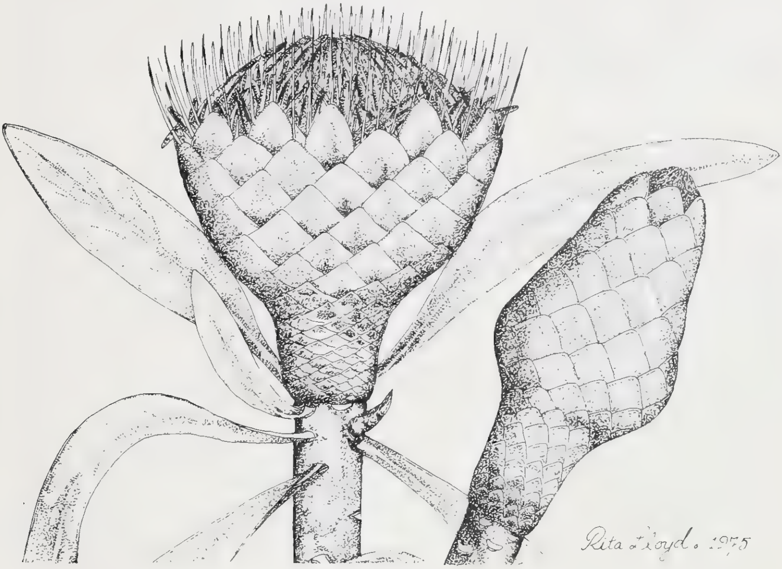

FIG. 1.
Protea laetans. Mature inflorescence and bud. (× $\frac{3}{4}$)

Type material: TRANSVAAL—2430 (Pilgrims Rest): hillside within Blyde Canyon Reserve at tourist resort (-DB), alt. 1 200 m. 5/5/75. *L. E. Davidson 2681* (J, holo.; NBG, PRE, K, MO, NU, iso).

Found growing between altitudes of 1 000 and 1 240 metres on a single hillside of Black Reef and Wolkberg quartzites in the Blyde Canyon Reserve at the tourist resort on the Eastern Transvaal Drakensberg. It is abundant on the grassy rocky hillside associated with *Bequaertiodendron magalismontanum, Cussonia natalensis* and *Faurea galpinii.* None of the other species of *Protea* which are found in the Blyde Canyon Reserve occurs on this hillside. A few isolated specimens of this species have been found elsewhere in the reserve. There are variations in the dimensions of the leaves and in the pubescence on the bracts which range from completely silvery to completely ferruginous, otherwise this species is remarkably uniform in general characteristics. The flowering period starts in mid-March, reaches a peak in mid-May and thereafter occasional flowers are to be found until the end of November. It is apparently resistant to fire.

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EVIDENCE FOR THE PRESENCE OF A GERMINATION INHIBITOR IN SEEDS OF *STRELITZIA* AIT.

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Abstract

Although seeds of *Strelitzia* exhibit a condition of dormancy, excised embryos were found to be capable of prompt and normal growth when placed in a suitable medium. Growth was, however, markedly inhibited on addition of seed coats. This inhibitory effect was unaffected by the presence or absence of light or by five years of dry storage of the seed but was significantly reduced in seed coats of germinated seeds.

Using a lettuce seed germination biotest as well as a biotest involving excised *Strelitzia* embryos, chromatograms of aqueous seed extracts were found to contain inhibitory fractions.

Uittreksel

GETUIENIS VIR DIE TEENWOORDIGHEID VAN 'N ONTKIEMINGSINHIBEERDER IN SADE VAN *STRELITZIA* AIT.

Hoewel sade van *Strelitzia* in 'n rustoestand verkeer, besit geïsoleerde embrio's die vermoë om vinnig en normaal te groei wanneer hulle in 'n geskikte medium geplaas word. Byvoeging van die omringende weefsels inhibeer hierdie groei egter aansienlik. Hierdie inhiberende effek word nie deur die aan- of afwesigheid van lig beïnvloed nie, is nog teenwoordig na vyf jaar van droë opberging van die saad, maar toon 'n betekenisvolle afname in ontkiemende sade.

Deur gebruik te maak van 'n slaaisaad biotoets asook 'n toets met geïsoleerde *Strelitzia* embrio's is vasgestel dat chromatogramme van waterige ekstrakte van die saad inhiberende fraksies bevat.

Introduction

Although seeds of the acaulescent species of *Strelitzia* do not germinate promptly, normal and rapid growth of excised embryos takes place when they are incubated in a suitable medium (Van de Venter & Small, 1974). This would seem to indicate that some or other factor, residing in the seed coat*, is responsible for dormancy.

Seed coats may be responsible for dormancy in various ways (Wareing, 1969; Egley, 1972). One possibility is that dormancy is maintained by means of germination inhibitors contained in the seed coat. Evidence that this mechanism could be operative in the case of *Strelitzia* is presented in this paper.

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*The term *seed coat* as used in this paper denotes all the tissues in the seed surrounding the embryo.

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MATERIALS AND METHODS

Embryo cultures

Excised embryos of *S. juncea* were used throughout as greater uniformity in growth was obtained with this material as was the case with excised embryos of *S. reginae*. No morphological differences between either the seeds or embryos of these species is apparent. In fact, the only obvious difference between these two species is a distinct difference in leaf morphology (Van de Venter, Small and Robbertse, 1975). To prepare the seeds for removal of their embryos, they were abraded and surface-sterilized by immersion for 2 minutes in concentrated sulphuric acid, rinsing for 1 minute in fast flowing tap water, and then immersion for 30 minutes in a 0,2% solution of mecuric chloride ($HgCl_2$). The seeds were then rinsed with one litre of sterile, distilled water and placed overnight on moist filter paper in sterile petri dishes. This imbibition period softened the seed coats sufficiently for the embryos to be removed with comparative ease.

The seed coats of these seeds were discarded and the embryos subsequently cultured in sterile White's nutrient solution (White, 1963) without vitamins. Two embryos were incubated per 30 ml of culture solution contained in conical flasks of 100 ml capacity.

Where seed coats were also added to the culture solutions, these were obtained from seeds of *S. juncea* or *S. reginae*, depending on the particular experiment. Whole, unabraded seeds were surface-sterilized in H_2SO_4 and $HgCl_2$ as described above and then rinsed with three, one litre volumes of sterile, distilled water. These seeds were not abraded because of the possibility that the exposed endosperm could absorb mercuric chloride. Water uptake by these seeds was slower than in the case of abraded seeds and they were therefore allowed to imbibe for three days as a softening procedure. The seeds were then cut in half and the embryos discarded. The seed coats of two seeds were added to the solution in each flask.

The flasks containing the embryos were continuously agitated on an orbital shaker, in the dark, at 25 ± 0,5 °C in a Controlled Environments E7H growth cabinet. After twelve days of incubation, growth was determined in terms of root length. The data were subjected to statistical analyses and lowest significant differences computed according to the method of Tukey (Steel and Torrie, 1960).

Extraction and chromatography

Twenty-five grams of month-old seeds of *S. reginae* were imbibed in distilled water for six days. The seeds were then frozen in liquid nitrogen, ground in a coffee mill and extracted three times (24 hour periods) with 200 ml volumes of distilled water. The extraction was performed at 4 °C under nitrogen. The extracts were pooled and filtered through a disc of Whatman number 42 filter paper after which the filtrate was concentrated by freeze-drying.

The concentrate was taken up in a little water and streaked onto Whatman number one chromatography paper. The chromatogram was developed by the descending method using isopropanol: 25% ammonia: water (10:1:1) as solvent. After the solvent front had moved 30 cm the chromatograms were dried at 35 °C for ten minutes. The chromatograms were cut into ten equal, transverse sections and the biological activity of each section was determined.

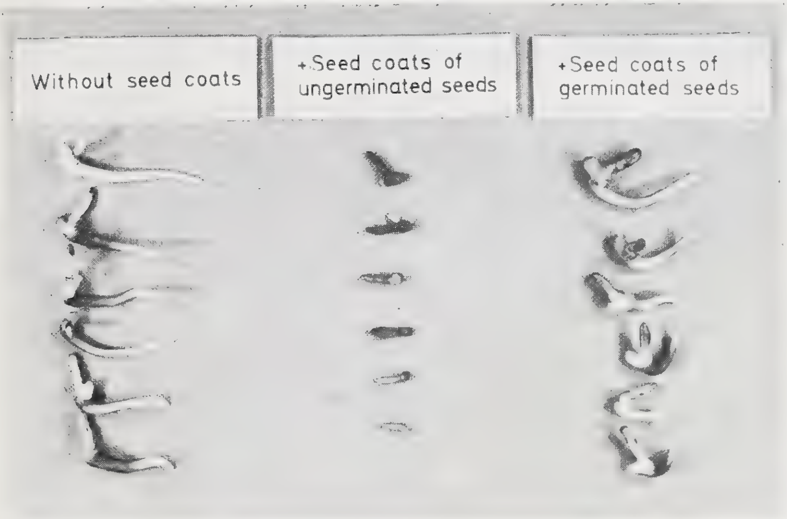
Without seed coats
+Seed coats of ungerminated seeds
+Seed coats of germinated seeds

FIG. 1.

Effect of seed coats from germinated and ungerminated *S. reginae* seeds on the growth of *S. juncea* embryos.

Bioassays

A lettuce seed germination test similar to that used by Black and Wareing (1959) was employed using the non-light requiring cultivar "Great Lakes". The seeds were incubated at 25 ± 0,5 °C and germination counts made after 48 hours.

It was realised that, although this bioassay was specific for germination inhibitors, more conclusive results would be obtained by making use of *Strelitzia* material. Adding chromatogram sections to excised *S. juncea* embryos in

White's medium and measuring growth after twelve days did not give satisfactory results. No satisfactory method for the sterilization of chromatogram sections could be found and contamination of the growth medium by micro-organisms was consequently severe. The variation in growth between different embryos also proved to be a major problem.

A biotest was therefore devised in which embryos were allowed to grow for nine days before the addition of chromatogram sections. Growth was measured on the twelfth day, that is, on the third day after addition of chromatogram sections. No contamination by micro-organisms was visible by the twelfth day as the period of incubation was probably too short to allow a large-scale multiplication of microbes. Variation in embryo growth was reduced to a minimum in this biotest by cultivating an abundance of embryos and visually selecting for uniformity on the ninth day.

RESULTS

Experiments with excised embryos

In the first experiment the effect of adding seed coats of four-month-old seeds of *S. juncea* and *S. reginae* to the growth medium containing excised *S. juncea* embryos was ascertained. Each treatment was replicated four times.

TABLE 1
Effect of seed coats of *S. juncea* and *S. reginae* on root length of excised *S. juncea* embryos.

Addition to culture medium	Mean root length of embryos (mm ± S.E.)
No addition (control)	21 ± 2,04
Seed coats of *S. juncea*	2 ± 0,25
Seed coats of *S. reginae*.	3 ± 0,85

The results in Table 1 show that the presence of seed coats had a decided inhibitory effect on the growth of excised embryos. The seed coats of both species had a similar inhibitory effect.

In a second experiment a comparison was made between the inhibitory effects of seed coats of freshly-harvested and year-old seeds of *S. juncea* in the light and in the dark. For the light treatment, continuous lighting was supplied by eight cool white fluorescent tubes with a light intensity of 7 000 lux at flask level. Flasks of the dark treatment were placed in the same growth cabinet but were covered with a single layer of household aluminium foil to exclude light. All manipulations prior to placing embryos and seed coats into the flasks were performed as quickly as possible under normal laboratory lighting conditions. Treatments were randomised in a 3×2 factorial design with six replicates.

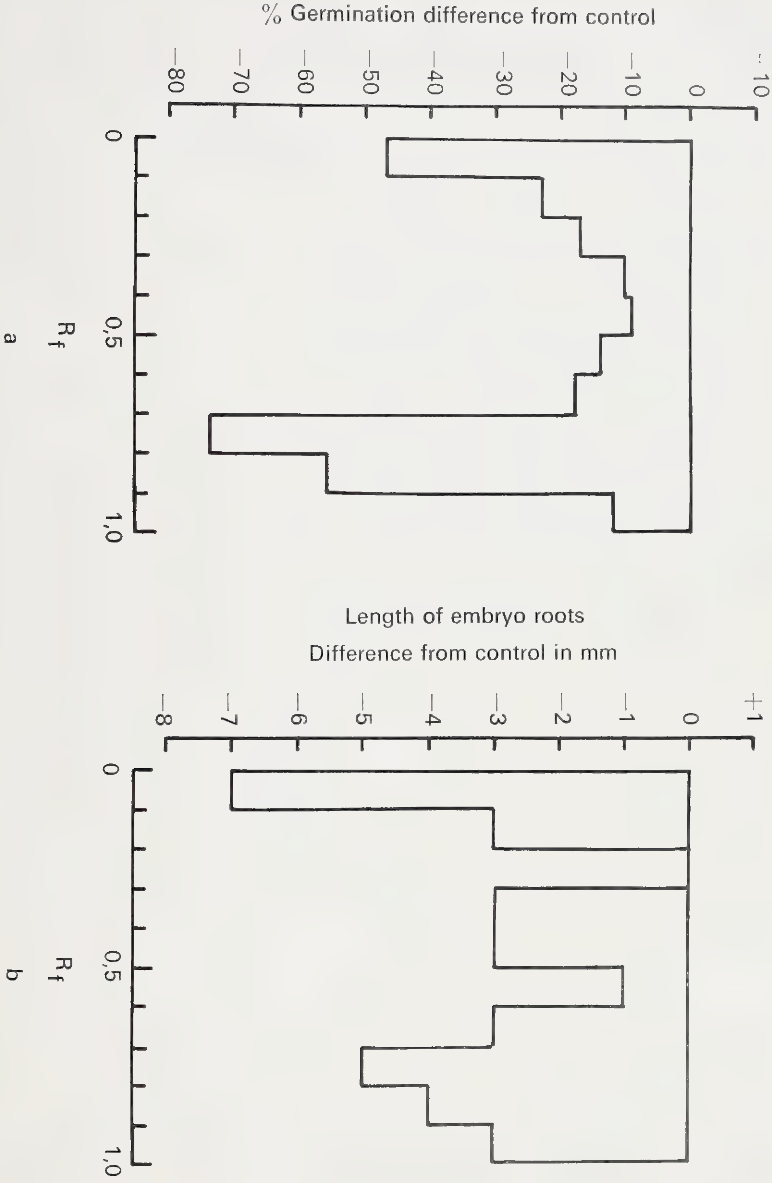

FIG. 2.

Inhibitory effect of aqueous extracts of *S. reginae* seeds.
(*a*) Effect on germination of lettuce seeds.
(*b*) Effect on root length of excised *S. juncea* embryos.

The results of this experiment (see Table 2) confirm the results of the first experiment concerning the inhibitory effect of seed coats on the growth of excised embryos. It can also be seen that the action of the inhibiting factor is as powerful in one-year-old seeds as it is in freshly harvested seeds.

TABLE 2

Effect of seed coats of different ages on the root length (in mm) of excised *S. juncea* embryos grown in light and darkness.

	Additions to growth medium of embryos			
	Control—no addition	Seed coats from freshly harvested seeds	Seed coats from year-old seeds	Mean
Light	29	6	7	14
Dark	35	6	4	15
Mean. . . .	32	6	6	

F value (seed coat effects): 80,56**
L S D (seed coat effects): 6 mm

The presence or absence of light did not influence the inhibiting action of seed coats. Growth of embryos in the absence of seed coats, however, was slightly better in the dark than in the light.

A further experiment was conducted on the effect of seed age on the inhibitory principle in seed coats. Seed coats of five-year-old *S. reginae* seeds were added to the growth medium of isolated embryos. A mean root length of 3 mm was recorded as compared to a root length of 23 mm in control treatments. The addition of seed coats of six-month-old seeds resulted in a root length of 2 mm.

In a fourth experiment, the effect of seed coats of germinated and ungerminated seeds of *S. reginae* on the growth of excised embryos was determined. The seed coats of germinated seeds were selected from seeds which had just started to germinate after incubation in petri dishes for two weeks. Seed coats of ungerminated seeds were obtained from seeds which had been allowed to imbibe water for only 15 hours. It was thought inadvisable to use ungerminated seeds which had been incubated for two weeks as there was no way of discerning which seeds were on the point of germination.

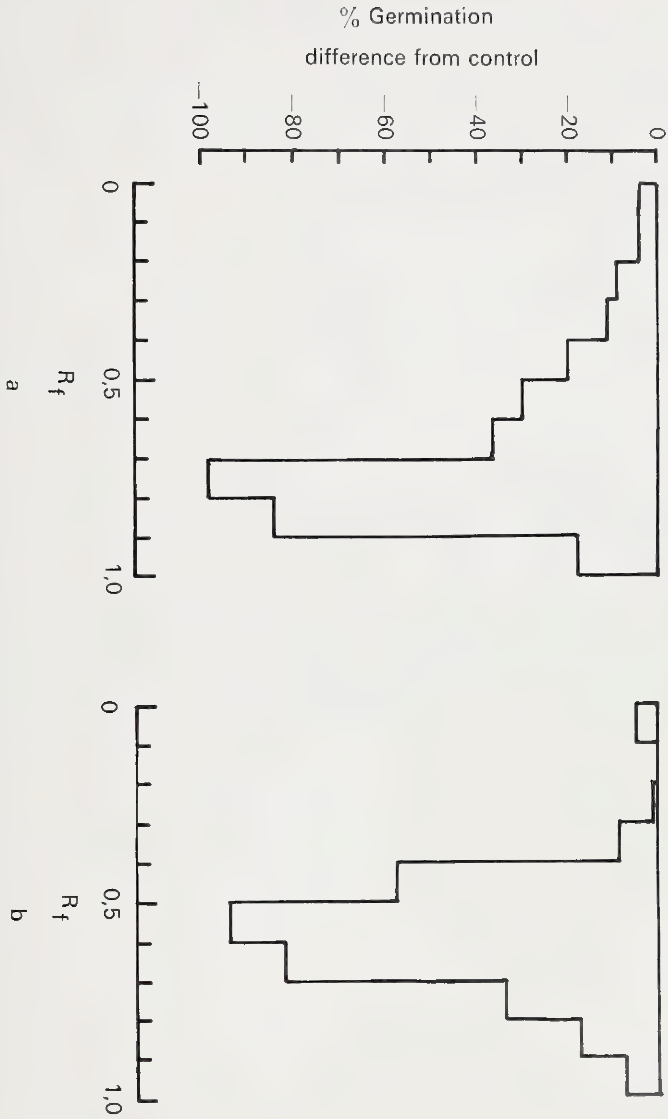

FIG. 3.

Effect of inhibitors on the germination of lettuce seed.
(*a*) Coumarin
(*b*) Abscisic acid.

Treatments were replicated six times. Three of the replicates containing seed coats from germinated seeds showed severe microbial contamination and were discarded. No sign of microbial growth was seen in any of the other flasks.

The results of this experiment are shown in Table 3 and embryos from the different treatments are pictured in Fig. 1.

TABLE 3

Effect of seed coats from germinated and ungerminated *S. reginae* seeds on the growth of *S. juncea* embryos.

Additions to culture medium	Mean embryo root length (mm)
Control—no addition	27
Seed coats of ungerminated seeds	2
Seed coats of germinated seeds	17

F value: 73,03* L S D: 6 mm

It can be seen that the effect of the inhibitor had been significantly reduced in the seed coats of germinated seeds. It is obvious, however, that the inhibitory effect had not been completely lost during germination as embryos growing in the presence of seed coats of germinated seeds showed significantly less growth than control embryos.

An experiment in which seed coats were added to the growth medium of actively growing embryos formed the basis of the bioassay reported in this paper. Treatments consisted of the addition of *S. reginae* seed coats to the growth medium of embryos which had been cultivated in isolation for three, six and nine days respectively. Treatments were also included where no seed coats were added at the commencement of incubation. Every treatment was replicated four times.

Twelve additional replicates of the control treatment were included in this experiment. After three, six and nine days of growth respectively, four control replicates were harvested to determine embryo root length at those stages. From these data it was possible to estimate the amount of embryo root growth that occurred after addition of seed coats. As asepsis had to be maintained, direct measurement of embryos at the time of adding seed coats could not be done. Increase in length after addition of seed coats was expressed as a percentage of the growth increase in untreated embryos over the same period.

TABLE 4

Root growth of excised *S. juncea* embryos after addition of *S. reginae* seed coats at different stages of growth.

Treatment	Final root length of embryo mm	Estimated increase in root length after addition of seed coats	
		mm	As % of control growth increase
Control—no seed coats added .	28	—	—
Seed coats added on first day .	4	4	14,0
Seed coats added after 3 days .	10	9	33,3
Seed coats added after 6 days .	9	4	17,4
Seed coats added after 9 days .	19	5	35,0

F value: 36,85** and L S D: 8 mm for final root lengths.

The results in Table 4 show that addition of seed coats to the growth medium significantly inhibited embryo root growth in all the treatments. The estimates of growth increase after addition of seed coats indicate that growth curtailment was severe.

Addition of seed coats to embryos which had already been growing for nine days resulted in their primary roots becoming swollen at their extremities. This can be interpreted as a greater inhibition of growth in length than in girth. It is interesting that coumarin is known to inhibit elongation of root cells while growth in width is apparently not affected (Avers and Goodwin, 1956 and Svensson, 1971). This phenomenon was not evident in any of the other treatments.

Extraction and chromatographic separation of the inhibiting principle

After having obtained evidence for the existence of an inhibitory factor in the seed coats of *Strelitzia* seeds, attempts were made to extract the inhibitor. The use of solvents such as methanol, acetone, ethyl acetate and chloroform gave results which were either negative or inconsistent. Consistent results were, however, obtained with aqueous extracts.

Figure 2A was compiled from the results obtained after extracts were made on two separate occasions. The lettuce germination biotest was replicated five times in the case of the first extraction and three times in the case of the second one. Similar results were obtained in both cases and the data was consequently pooled.

Two bands of inhibition were found on the chromatograms. Inhibition was found between R_f values 0,0 and 0,1 as well as between R_f 0,7 and 0,9. When viewed under ultraviolet light, the chromatograms also showed a light blue fluorescence in these regions.

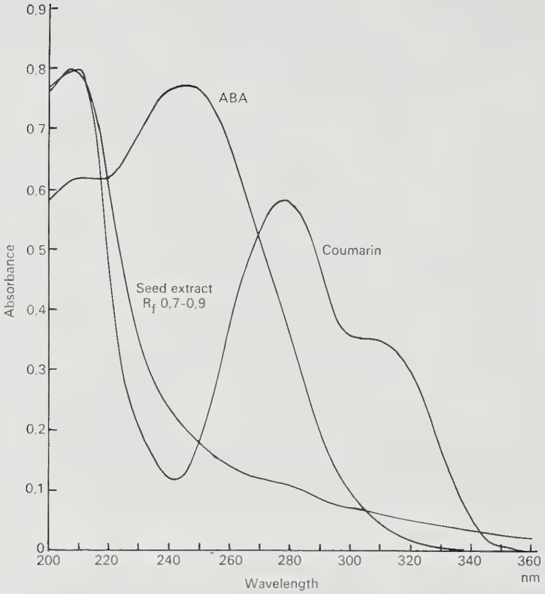

FIG. 4.

A comparison of the UV absorption spectra of abscisic acid (ABA), coumarin and an aqueous seed extract of *S. reginae*.

Peaks of inhibition were found at the same R_f values using the excised embryo biotest (Fig. 2B).

The results of tests measuring the biological activity of chromatograms of coumarin (Hopkin and Williams) and abscisic acid (Miles-Seravac) appear in Fig. 3.

Abscisic acid activity was found at R_f 0,4–0,7 which did not correspond to zones of inhibition found on chromatograms of seed extracts. In the case of coumarin, the activity at R_f values 0,7–0,9 coincided with the one zone of inhibition found on chromatograms of the seed extract.

Abscisic acid and coumarin were eluted from these zones on the chromatograms using distilled water, and their ultraviolet absorption spectra determined in a Pye Unicam SP 1800 spectrophotometer. The inhibitor in the seed extract partitioning at R_f 0,7–0,9 was also eluted in water and its absorption spectrum compared with those of ABA and coumarin. The absorption spectra are shown in Fig. 4.

Peak absorption was found at 245 nm in the case of ABA and at 277 nm in the case of coumarin. The absorption spectrum of the seed extract did not correspond to that of ABA or coumarin.

DISCUSSION

Working with dormant *Iris* seeds, Randolph and Cox (1943) found that excised embryos were capable of normal growth and development when placed on a suitable growth medium. When endosperm tissue was brought in intimate contact with these embryos, however, growth was markedly inhibited and progressed slowly in an atypical manner. Their conclusion that inhibitory substances were present in the endosperm of these seeds was confirmed when Kartaschoff (1958) was able to extract inhibitory substances from this tissue.

In the experiments reported in this paper, a similar approach was used and similar results were found. Excised embryos of *Strelitzia* were found to be capable of prompt and normal growth when placed in a suitable medium but growth was markedly inhibited on addition of seed coats. This suggests that the tissues surrounding the embryo contain an inhibitory substance which could possibly be related to the dormancy of the seed. The experiments have also shown that the effect of this inhibitor is not affected by the presence or absence of light and that it exists in the seed during extended periods of dry storage. Seeds of *S. reginae* do not retain their viability for very long (Van de Venter and Small, 1974) and a batch which had been stored for five years was found to have lost viability completely. In spite of this, the seed coats showed an inhibitory effect similar to that of fresh seeds. Seeds which, under natural conditions germinate before their viability is lost must, therefore, have some or other mechanism whereby they are able to overcome the effect of this inhibitor.

It was shown that seed coats of germinating seeds lose a great deal of their inhibitory effect. This does not necessarily imply a reduction in the absolute amount of inhibitor present. It is possible that the formation of a growth stimulator shifts the inhibitor/stimulator balance in favour of growth. The regulation of germination and growth by this type of interaction has been emphasized much in recent years by physiologists such as Amen (1968), Kefeli (1971) and Villiers (1972).

The presence of inhibitory fractions on chromatograms of aqueous extracts of *S. reginae* seeds provided further evidence for the existence of a germination inhibitor in the seed.

Altogether two zones of inhibition were found on the chromatograms. It is not known at present whether the inhibitory activity detected at R_f values 0,0–0,1 is caused by a "true" inhibitor or whether this zone merely represents a toxic effect. An aqueous extract contains many compounds such as proteins, sugars and salts and the possibility that some of these compounds could affect germination adversely in the concentration occurring in the extract should be taken into account.

On the other hand, although inhibitory activity is evident in aqueous extracts of ground seeds, it was later found (unpublished results) that germination is not promoted when scarified seeds are subjected to an extensive leaching treatment. It is therefore possible that the greater portion of the inhibitor is bound *in vivo* to some other molecule in the seed. This bound form of the inhibitor might remain on the origin of the chromatogram while the free portion is able to descend to R_f 0,7–0,9. If this was the case the same inhibitor could be responsible for both zones of activity on the chromatogram.

There were reasons to suspect that the inhibitory effect of the seed coats could be ascribed to coumarin, a well-known naturally occurring germination inhibitor. The fact that in a certain case the presence of seed coats resulted in the swelling of root tips has already been mentioned as evidence of this. In germination experiments to be reported in a later paper, it was found that substances such as thiourea, cysteine and BAL (2,3-dimercapto-1-propanol) stimulated germination of dormant *S. reginae* seeds. These substances are known to reverse the inhibitory effect of coumarin (Nutile, 1945; Thimann and Bonner, 1949; Mayer and Evenari, 1952). It was also found that coumarin resulted in a zone of inhibitory activity at an R_f value of 0,7–0,9 on the chromatogram, corresponding to a similar zone of inhibition in the case of an aqueous seed extract. Absorption spectra of eluates have, however, failed to confirm any similarity between the inhibitor in the seed and coumarin. No evidence could be obtained that the inhibitor was ABA.

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INHIBITORS ARE NOT RESPONSIBLE FOR POOR GERMINATION OF *PROTEA COMPACTA* SEED

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Abstract

Evidence is provided which shows that in the case of *Protea compacta* poor germination is not due to the presence of inhibitors but rather to a lack of promoters. It would appear as if butanol-soluble cytokinins and gibberellin-like substances together control the germinability of the seed.

Uittreksel

INHIBEERDERS IS NIE VERANTWOORDELIK VIR DIE SWAK ONTKIEMING VAN *PROTEA COMPACTA* SAAD NIE

Bewyse is gevind wat daarop dui dat in die geval van *Protea compacta* swak ontkieming nie te wyte is aan die teenwoordigheid van inhibeerders nie, maar eerder toegeskryf kan word aan 'n tekort aan ontkiemingstimuleerders. Dit wil voorkom asof butanol-oplosbare sitokiniene en gibberellienagtige verbindings gesamentlik die ontkiembaarheid van die saad beheer.

Introduction

Vogts in 1960 inferred that the poor germination of proteaceous seed could be explained by the presence of inhibitors. This assumption had an important influence on subsequent research in that it stimulated interest in the isolation of inhibitors but, perhaps unfortunately, it also directed attention away from other factors that could be responsible for reduced germinability, especially as dormancy can also be caused by a lack of promoters (Villiers and Wareing, 1965). Substances that inhibit lettuce seed germination can be leached and extracted from the seed of a number of Proteaceae species. The removal of these compounds however, did not result in any significant improvement of germination (Brown and Van Staden, 1971; Van Staden and Brown, 1972; 1973). As their removal must be correlated with an enhancement in germination in order for them to be considered as an obstacle to germination the question immediately arises whether these compounds are indeed involved in germination. To determine whether inhibitors have an overriding effect in regulating germination in *Protea compacta* seed, or whether germination is determined by a balance between inhibitors and promoters, the effects of favourable environmental factors on germination (Brown and Van Staden, 1973a) and on the levels of endogenously occurring growth substances were investigated.

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MATERIALS AND METHODS

The seed of *Protea compacta* R. Br. used in the present investigation was purchased from the Department of Forestry, Pretoria.

Stratification and oxygen incubation

Seed was imbibed in distilled water for 24 hours. Samples were subsequently incubated on moist filter paper at 5°C and 25°C for 0, 30, 60 and 90 days respectively and then extracted for growth regulators. A second batch of seeds was placed on moist filter paper in 500 ml flasks. The flasks were evacuated and flushed daily with air, oxygen or nitrogen. Seeds were incubated in each gas for 0, 10, 15 and 20 days respectively in a germinator with temperatures alternating between 10°C for 8 hours and 20°C for 16 hours and subsequently extracted for growth regulators. Each experiment was repeated at least twice.

Germination data were obtained from separate samples of seed treated as described above.

Extraction and bioassay of growth regulators

Ten grammes of non-germinated embryo material were extracted for each hormone. Cytokinins were extracted and assayed by means of the soybean bioassay as previously described (Van Staden, Webb and Wareing, 1972).

Gibberellin-like substances were extracted using a technique based on that of Phillips (1972), but omitting the agar-diffusion step. Embryo material was extracted directly in 80% methanol. The aqueous extracts obtained were partitioned with three equal volumes of redistilled ethyl acetate at pH 2.5. The pooled ethyl acetate fraction, containing acidic and possibly some of the neutral gibberellins, was reduced to dryness under vacuum at 35°C and the residue taken up in a small volume of ethyl acetate.

For inhibitors, embryo material was extracted as for gibberellins, except that the acidified aqueous extract was partitioned with redistilled ether.

Both the gibberellin and inhibitor extracts were strip-loaded onto Whatman No. 1 chromatography paper and separated with *iso*-propanol: ammonia: water (10:1:1 v/v). The dried chromatograms were divided into 10 equal strips. Gibberellin-like activity in the acidic ethyl acetate fractions was determined in the *Rumex* leaf senescence assay developed by Whyte and Luckwill (1966). Inhibitor levels were determined using the lettuce seed germination assay (Sankhla and Sankhla, 1968).

RESULTS

Figure 1 shows that incubation of seed in oxygen or at a low temperature enhanced germination of *Protea compacta* seed. Although there were minor fluctuations in the levels of inhibitors in the acidic ether and aqueous fractions of embryo extracts, no major trends of changes in inhibitor levels after incubation at 5°C or 25°C were recorded (Fig. 2). The results obtained with incubation in air, oxygen and nitrogen showed similar trends and are therefore not presented. However, incubation at low temperatures (Fig. 3) and in the presence of various gases (Fig. 4) resulted in increases in promoter levels. In the case of the former treatment the level of butanol-soluble cytokinins reached a peak after 30 days of chilling and the level of acidic gibberellin-like substances increased progressively over a period of 60 days. The highest level of butanol-soluble cytokinins was correlated with maximum germination which was 50% higher than that of the control (Fig. 1B). Incubation at 25°C resulted in a drop in the levels of both promoters. The fact that this decrease in promoter levels was correlated with a very low germination percentage suggests that poor germination may be associated with a lack of promoters rather than the presence of inhibitors.

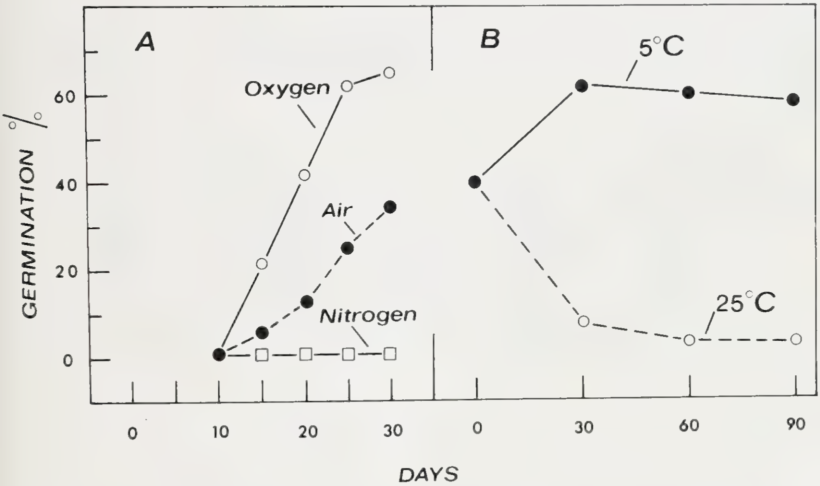

FIG. 1.
A. The effect of air, oxygen and nitrogen on the germination of *Protea compacta* seed. B. Germination of seed of *Protea compacta* after incubation at 5°C and 25°C for 0, 30, 60 and 90 days, respectively.

The levels of butanol-soluble cytokinins dropped during the first ten days of incubation in air, oxygen and nitrogen (Fig. 4). Thereafter the levels increased again relative to the ten-day levels, each reaching a peak at 15 days. However, whereas the peak level in oxygen represented an increase of 16% over the level of the control, the peaks in air and nitrogen were 20% and 40% below the control, respectively. The increase in butanol-soluble cytokinins with oxygen treatment occurred just before a period in which the maximum rate of germination occurred (Fig. 1A). Sixty-seven percent of the seeds germinated in oxygen, whereas 40% germinated in air and no germination took place in nitrogen.

Incubation in the different gases resulted in a similar trend in the levels of acidic gibberellin-like substances. A peak of activity was shown in each gas at 15 days (Fig. 4). However, this increase in gibberellin-like substances appeared to improve germination only when accompanied by a simultaneous increase in butanol-soluble cytokinins (oxygen incubation).

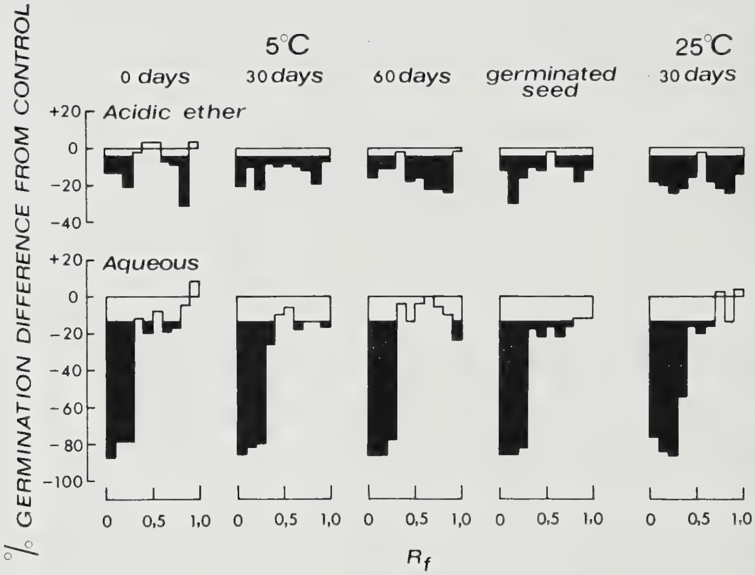

Fig. 2.
Inhibitors from acidic ether and aqueous fractions of embryo extracts of *Protea compacta* seed incubated at 5°C and 25°C, respectively. Extracts were chromatographed on paper in *iso*-propanol: ammonia: water (10:1:1v/v) and assayed with the Grand Rapids lettuce seed germination bioassay. Shaded areas represent differences significant from water controls at the 1% level.

Discussion

The levels of inhibitors extracted from embryos were similar in treatments which gave maximum germination and those in which no germination occurred. It thus seems reasonable to assume that the inhibitors extracted were not of importance in the regulation of germination. These results support the findings of leaching experiments (Brown and Van Staden, 1973b) and the report that poor germination of seed of *Leucospermum cordifolium* cannot be directly attributed to the presence of inhibitors (Van Staden and Brown, 1973).

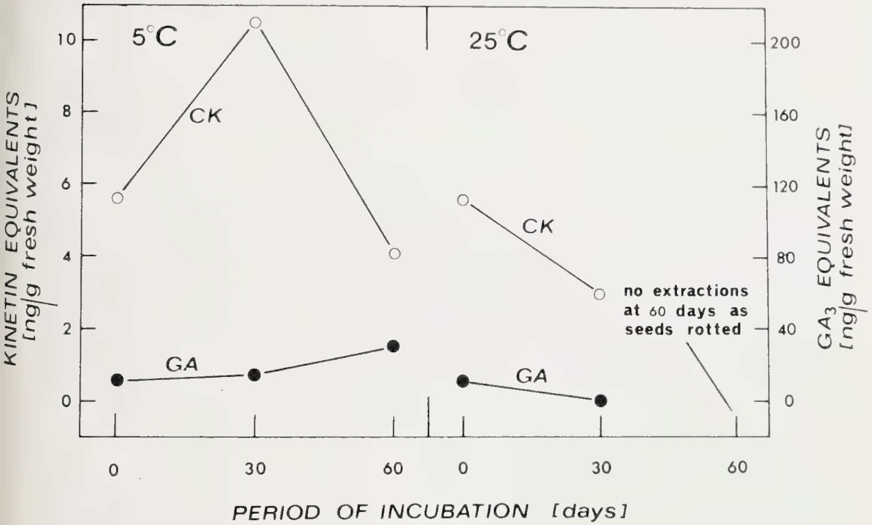

Fig. 3.

The effect of incubation at 5°C and 25°C on the levels of butanol-soluble cytokinins and acidic gibberellin-like substances in seed of *Protea compacta*. Butanol-soluble cytokinins measured by the soybean callus bioassay (CK). Acidic gibberellin-like substances measured by the *Rumex* leaf senescence retardation bioassay (GA).

Increases in promoter levels were correlated with maximum germination suggesting that poor germinability in this species is mainly due to a lack of promoters. Both butanol-soluble cytokinins and acidic gibberellin-like substances are apparently required for germination. This differs from the hypothesis of Khan (1971) in which gibberellin was regarded as the primary stimulus needed for germination. In seed of *Protea compacta* gibberellins do not appear to be primarily responsible for improved germination. In the absence of oxygen, a condition under which no germination occurred, cytokinin levels were low, suggesting that the synthesis of these compounds is oxygen dependent.

Acknowledgments

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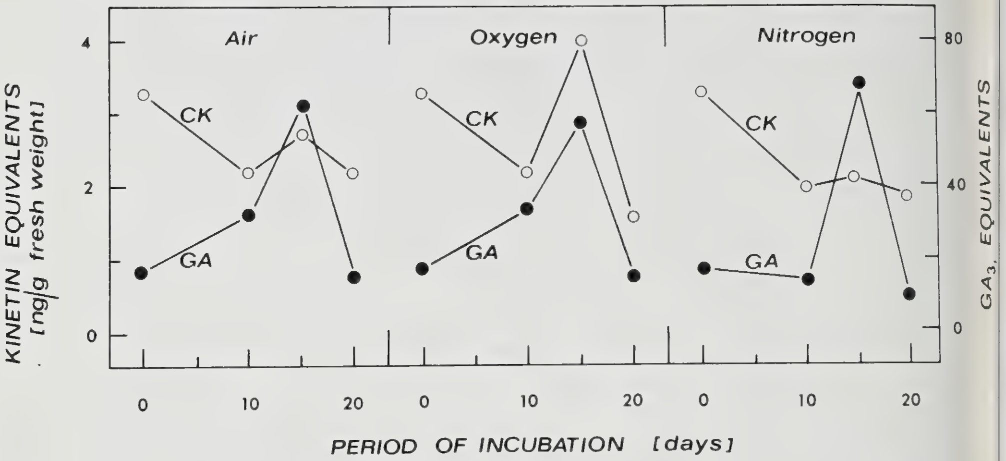

FIG. 4.
The effect of incubation in air, oxygen and nitrogen on the level of butanol-soluble cytokinins and acidic gibberellin-like substances in seed of *Protea compacta*. Butanol-soluble cytokinins measured by the soybean callus bioassay (CK). Acidic gibberellin-like substances measured by the *Rumex* leaf senescence retardation bioassay (GA).

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TERATOSPHAERIA PROTEAE-ARBOREAE AND *MYCOSPHAERELLA JONKERSHOEKENSIS*, TWO NEW ASCOMYCETES ON *PROTEA* IN SOUTH AFRICA

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ABSTRACT

Two new species of Ascomycetes on *Protea spp*. in the Cape Province are described and compared with related fungi on South African Proteaceae. *Teratosphaeria proteae-arboreae* Van Wyk, Marasas & Knox-Davies sp. nov., on *P. arborea* Houttuyn is characterized by ascostromata that are irregularly crowded together in the centre of circular, raised leaf spots and ascospores 18–32 × 5–9μm in size. It differs in these respects from *T. fibrillosa* Syd. which produces ascocarps in centrifugal, branched, radiating lines, and has considerably larger ascospores. *Mycosphaerella jonkershoekensis* Van Wyk, Marasas & Knox-Davies sp. nov., on *P. repens* L. and *P. barbigera* Meisn. differs from *M. proteae* (Syd.) Von Arx in the production of circular, necrotic leaf spots, smaller asci, and smaller, somewhat differently-shaped ascospores.

UITTREKSEL

TERATOSPHAERIA PROTEAE-ARBOREAE EN *MYCOSPHAERELLA JONKERSHOEKENSIS*, TWEE NUWE ASKOMISETE OP *PROTEA* IN SUID-AFRIKA

Twee nuwe spesies van Askomisete op *Protea spp*. in die Kaapprovinsie word beskryf en vergelyk met verwante fungi op Suid-Afrikaanse Proteaceae. *Teratosphaeria proteae-arboreae* Van Wyk, Marasas & Knox-Davies sp. nov., op *P. arborea* Houttuyn word gekenmerk deur askostromata wat onreëlmatig opeengedruk in die middel van ronde, verhewe blaarvlekke voorkom en askospore 18–32 × 5–9μm in grootte. Dit verskil in hierdie opsigte van *T. fibrillosa* Syd. wat askokarpe in sentrifugale, vertakte, uitstralende lyne vorm en wat aansienlik groter askospore het. *Mycosphaerella jonkershoekensis* Van Wyk, Marasas & Knox-Davies sp. nov., op *P. repens* L. en *P. barbigera* Meisn. verskil van *M. proteae* (Syd.) Von Arx in die veroorsaking van ronde, gesonke, nekrotiese blaarvlekke en die vorming van kleiner askusse en kleiner askospore wat ook effens in vorm verskil.

In the course of an investigation of the foliicolous fungi of South African Proteaceae (Van Wyk, 1973), two interesting Ascomycetes were collected on *Protea spp*. in the Cape Province. Both of these fungi belong to genera (*Teratosphaeria* and *Mycosphaerella*) which are each represented by a single known species on the genus *Protea* in South Africa. The present collections differ from the existing species in several respects and are consequently described here as new species. The type specimens are deposited in the Mycological Herbarium of the Plant Protection Research Institute, Private Bag X134, Pretoria, Republic of South Africa (PREM).

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Teratosphaeria proteae-arboreae Van Wyk, Marasas et Knox-Davies sp. nov.

Maculae amphigenae, orbiculatae, 1–3 mm diam., elevatae, atrae, marginibus puniceis. *Acostromata* in contextu matricis immersa, unilocularia, fusca vel atra, pyriformia, globosa vel depresso-globosa, 120–194 × 113–234 μm, pariete plectenchymato 10–20 μm diam., poro per stoma erumpente. *Asci* sessiles, obclavati vel lageniformes, bitunicati, apice crassius tunicati, octospori, 70–96 × 18–35 μm, paraphysibus deliquescentibus. *Ascosporae* oblique monostichae vel distichae, cylindraceae utrinque rotundatae, rectae, medio uniseptatae, leniter constrictae, contentu subtiliter granulato, primum hyalinae, deinde brunae 18–32 × 5–9 μm. *Spermogonia* intermixta cum ascostromatibus, spermatiis hyalinis, continuis bacillaribus, 1,6–3,1 × 1,0 μm.

Hab. in foliis vivis *Protea arborea* Houttuyn, Jonkershoek, Stellenbosch, Cape Province, Republic of South Africa, 21.6.1971, leg. *Van Wyk* (PREM *44801*, holotypus).

Leaf Spots amphigenous, circular, 1–3 mm diam., raised and black in the centre due to the development of ascocarps, surrounded by a narrow pinkish margin which may enlarge to form a necrotic zone (Figs. 1,2). *Ascostromata* crowded, dark-brown to black, unilocular, pyriform or ellipsoidal to subglobose and flattened above and on the sides, 120–194 μm high and 113–234 μm wide, immersed in the leaf tissue below the epidermis with the apex penetrating the stomata and opening by means of a porus (Fig. 4). Locular wall 10–20 μm wide, composed of several layers of dark-brown plectenchymatous cells. No superficial mycelium present, but strands of brown, septate, vegetative hyphae extend from the ascostromata into the intercellular spaces of the mesophyll. *Asci* basal, surrounded by delicate paraphysoids that gelatinise at a very early stage, sessile, obclavate or lageniform, bitunicate with the wall markedly thickened towards the apex, eight-spored, 70–96 × 18–35 μm. *Ascospores* obliquely monostichous or distichous, cylindrical with both ends rounded, straight, one-septate in the middle, slightly constricted at the septum, surface finely granular, at first hyaline, becoming light-brown at maturity, 18–32 × 5–9 μm (Fig. 5). *Spermagonia* occur intermingled with the ascocarps and have the same general structure but contain a hymenium of spermatiophores and minute, one-celled, hyaline, bacillar spermatia, 1,6–3,1 × 1,0 μm.

On living leaves of *Protea arborea* Houttuyn, Jonkershoek, Stellenbosch, Cape Province, 21.6.1971, *Van Wyk* (PREM *44801*, holotype); 1.11.1972, *Van Wyk* (PREM *44921*, paratype).

The genus *Teratosphaeria* was established by Sydow and Sydow (1912) for a single species, *T. fibrillosa* Syd., on *Protea arborea* (= *P. grandiflora* Thunb.) from Bains Kloof, Cape Province (PREM *1217*). This species was characterised by the arrangement of the ascocarps in "centrifugal, irregularly branched, radiating lines" (Doidge, 1922). The new species described here differs from the

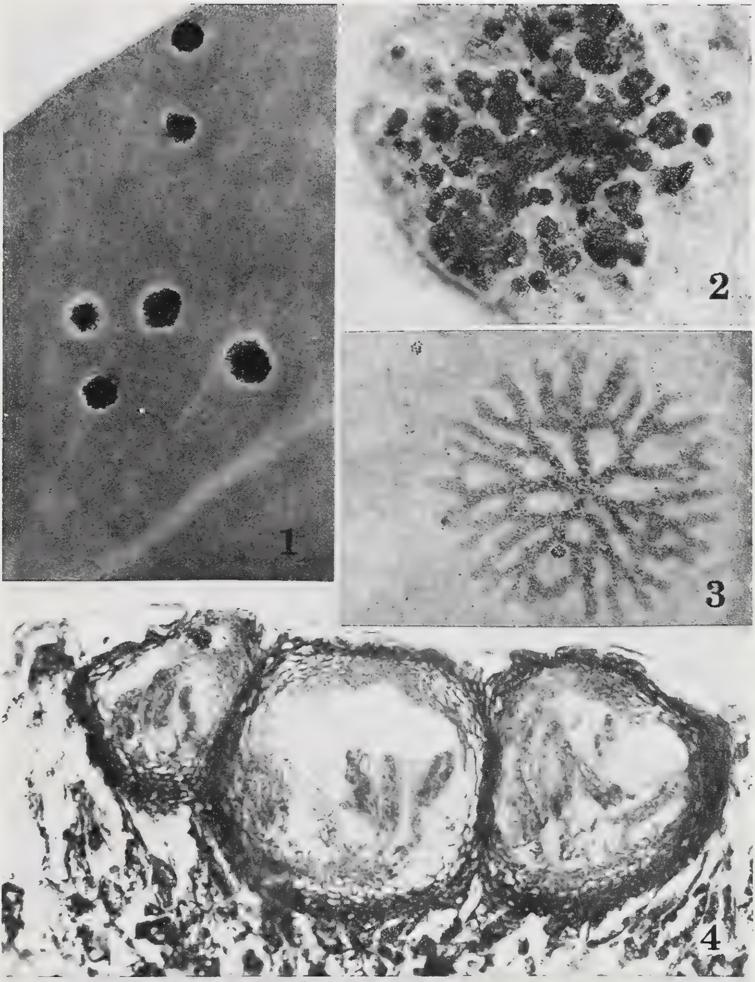

FIG. 1–6.
Teratosphaeria proteae-arboreae (PREM 44801, type) and *T. fibrillosa* (PREM 41812) on *Protea arborea*. 1. *T. proteae-arboreae*, circular, raised leaf spots, ×4. 2. *T. proteae-arboreae*, black ascostromata irregularly crowded together in the centre of raised leaf spots, ×50. 3. *T. fibrillosa*, ascostromata arranged in branched, radiating lines, ×4. 4. *T. proteae-arboreae*, section through ascostromata immersed in the mesophyll, ×250. 5. *T. proteae-arboreae*, ascospores, ×1 000. 6. *T. fibrillosa*, ascospore, ×1 000.

type collection of *T. fibrillosa* (PREM *1217*) in that the ascostromata are not arranged in this characteristic pattern (Fig. 3) but are irregularly crowded together in the centre of circular, raised leaf spots (Figs. 1, 2). The ascospores of the new species are also considerably smaller (18–32 × 5–9 μm, Fig. 5) than those of *T. fibrillosa* (35–52 × 8–12 μm, Fig. 6) as reported by Sydow and Sydow (1912), Theissen and Sydow (1915), Doidge (1922) and Müller and Von Arx (1962).

The differences between the two species in the appearance of the leaf spots and the arrangement of the ascocarps are not due to a host effect because *T. fibrillosa* (PREM *1217*, PREM *41812*) as well as the new species (PREM *44801*, PREM *44921*) were compared on the same host, *P. arborea* (Figs. 2, 3). The new species has incidentally been found on *P. arborea* only, while *T. fibrillosa* is known to occur on *P. arborea* (= *P. grandiflora*) as well as *P. abyssinica* Willd and *P. caffra* Meisn. (Sydow and Sydow, 1912; Doidge 1922, 1950; Müller and Von Arx, 1962). The difference in ascospore size can also not be attributed to a difference in the stage of maturity of the spores. Our ascospore measurements of *T. proteae-arboreae* were based on brown, mature ascospores and these were compared with measurements of brown, mature ascospores of *T. fibrillosa* on *P. arborea* (PREM *41812*) which we found to be 37,5–50,0 × 7,5–10,0 μm (Figs. 5, 6).

Mycosphaerella jonkershoekensis Van Wyk, Marasas et Knox-Davies sp. nov.

Maculae amphigenae, orbiculatae, infossae, griseae vel brunae, marginibus elevatis fuscis, usque ad 5 mm diam. *Ascostromata* amphigena, solitaria, unilocularia, atra, pyriformia vel subglobosa, in contextu matricis immersa, 90–122 × 88–136 μm, pariete plectenchymato 8,2–29,8 μm diam. poro papilliformi per stoma erumpente. *Asci* aparaphysati, sessiles vel breviter stipitati, pyriformes vel obclavati, bitunicati, apice rotundati et apice crassius tunicati, octospori, 32,0–57,2 × 10,2–15,9 μm. *Ascosporae* oblique monostichae, distichae vel tristichae, hyalinae vel subhyalinae, ellipsoideae utrinque rotundatae, uniseptatae, non constrictae, 11,2–20,7 × 3,9–7,6 μm, loculo superiore rotundato, 6,9–9,9 × 2,0–4,9 μm, loculo inferiore aequilongo vel parce longiore, 7,3–9,9 × 2,0–4,6 μm.

Hab. in foliis vivis *Protea repens* L., Jonkershoek, Stellenbosch, Cape Province, Republic of South Africa, 9.9.1971, leg. *Van Wyk* (PREM *44830*, holotypus).

Leaf spots amphigenous, circular, sunken, necrotic, parchment-like, greyish to light-brown with a raised, dark-brown margin, visible on both sides of the leaf, up to 5 mm diam., discrete and regular in outline, except when becoming confluent to form larger lesions (Figs. 7, 8). *Ascostromata* amphigenous, unilocular, solitary, black, pyriform or subglobose, subepidermal and immersed in the mesophyll below the stomata, apex penetrating the stomata and opening by means of a papilla-like, protruding porus, 90–122 μm high, 88–136 μm wide, locular wall 8,2–29,8 μm diam. and composed of several layers of dark-brown, plectenchymatous cells (Fig. 12). *Asci* aparaphysate, sessile or very briefly stipitate, obclavate or pyriform, bitunicate with the wall markedly thickened at the rounded apex, eight-spored, 32,0–57,2 × 10,2–15,9 μm. *Ascospores* obliquely monostichous, distichous or tristichous, hyaline or subhyaline, ellipsoidal and tapering towards the rounded ends, one-septate, not constricted, 11,2–20,7 × 3,9–7,6 μm; upper cell broadly rounded at the apex 6,9–9,9 × 2,0–4,9 μm; lower cell equal in length or slightly longer than the upper cell and narrowing slightly towards the rounded base, 7,3–9,9 × 2,0–4,6 μm (Fig. 10).

On living leaves of *Protea repens* L., Jonkershoek, Stellenbosch, Cape Province, 9.9.1971, *Van Wyk* (PREM *44830*, holotype); *Protea barbigera* Meisn., Assegaaibos, Stellenbosch, 1.11.1972, *Van Wyk* (PREM *44924*, paratype).

M. jonkershoekensis is related to *M. proteae* (Syd.) Von Arx, which is widespread on a number of *Protea spp.* in South Africa (Doidge, 1921, 1950; Müller & Von Arx, 1962). *M. proteae* was first described as *Didymella maculiformis* Winter on *P. arborea* Houttuyn (= *P. grandiflora* Thunb.) from the Cape Province (PREM *3396*) by Winter (1884). Material on *P. flanaganii* Phillips (PREM *5163*) was later described as *Oligostroma proteae* by Sydow & Sydow (1914). The type collections of *D. maculiformis* and *O. proteae* were examined by Von Höhnel (1917), who found them to be identical. The same conclusion was reached by Doidge (1921), who made the new combination *Oligostroma maculiformis* (Winter) Doidge. This species was finally transferred to the genus *Mycosphaerella* as *M. proteae* (Syd.) Von Arx by Müller & Von Arx (1962).

We examined the following collections of *M. proteae* in the Mycological Herbarium, Pretoria (PREM): *Protea arborea* Houttuyn (= *P. grandiflora* Thunb.), *3396* (type of *Didymella maculiformis* Winter); *P. amplexicaulis* R. Br., *44822; P. barbigera* Meisn., *44820, 44925, P. compacta* R. Br., *44825; P. cordata* Thunb., *44818; P. cynaroides* L., *44819; P. eximia* (Salisb. ex Knight) Fourcade, *44823; P. flanaganii* Phillips, *5163* (type of *Oligostroma proteae* Syd.); *P. grandiceps* Trattinick, *44828; P. laurifolia* Salisb. ex Knight, *44821; P. neriifolia* R. Br., *44815, 44816; P. obtusifolia* Buek. ex Meisn., *44827; P. pulchra* Rycroft, *44817; P. punctata* Meisn., *44826; P. speciosa* L., *44824; P. stokoei* Phillips, *44829.*

The leaf spots caused by *M. proteae* on the different hosts listed above are quite variable in appearance, but typically they are amphigenous, reddish-brown to grey or black, roughened, irregular in outline, but clearly delimited by a reddish-brown margin, usually not necrotic, raised and frequently becoming dome-shaped with a corresponding concave retraction of the abaxial leaf

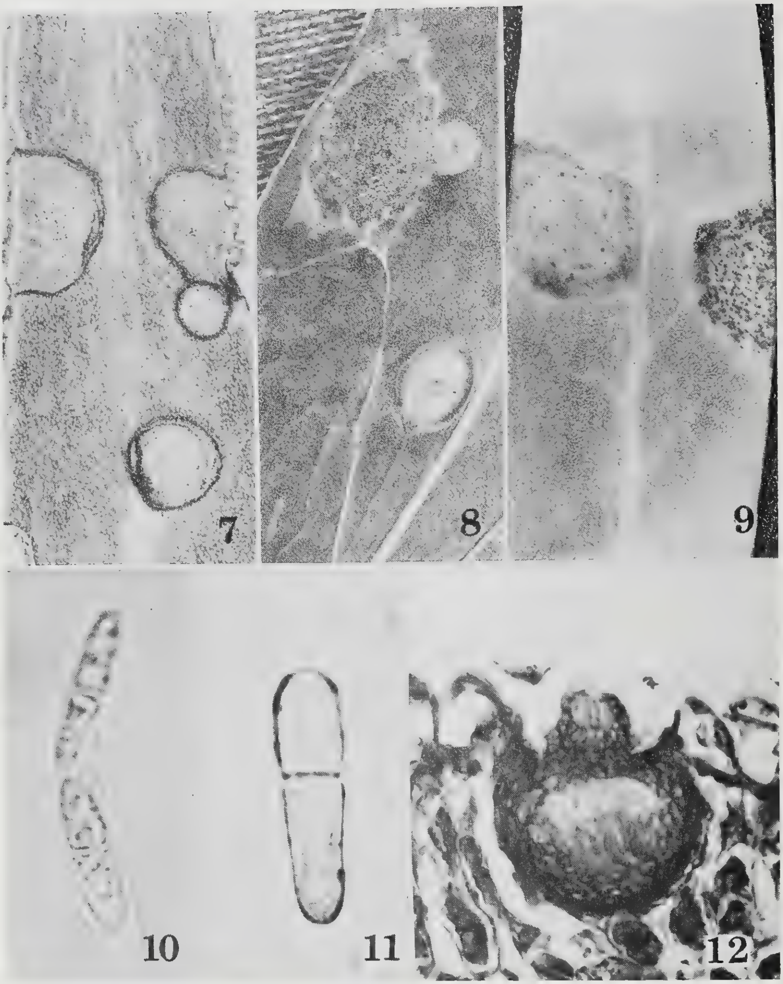

FIG. 7–12.

Mycosphaerella jonkershoekensis and *M. proteae*. 7. *M. jonkershoekensis* on *Protea repens* (PREM 44830, type), circular, sunken, necrotic leaf spots with raised margins, ×4. 8. *M. jonkershoekensis* (PREM 44924) and *M. proteae* (PREM 44925) on *P. barbigera*, ×2,5. The large, irregular, raised leaf spot is caused by *M. protea* and the small, circular, discrete leaf spots are typical of *M. jonkershoekensis*. 9. *M. proteae* on *P. neriifolia* (PREM 44816), irregular, roughened, raised leaf spots, ×4. 10. *M. jonkershoekensis* on *P. repens* (PREM 44830), ascospores, × 1 500. 11. *M. proteae* on *P. neriifolia* (PREM 44816), ascospore, × 1 500. 12. *M. jonkershoekensis* on *P. repens* (PREM 44830), section through ascostroma immersed in the mesophyll, ×390.

surface, up to 10 mm diam. or larger by confluence (Figs. 8, 9). These leaf spots are quite distinct from the typical circular, sunken, necrotic lesions caused by *M. jonkershoekensis*. The differences in the leaf spots caused by the two species are most clearly seen in the collection on *P. barbigera* in which *M. jonkershoekensis* (PREM *49924*) as well as *M. proteae* (PREM *44925*) occur on the same leaves (Fig. 8). It is interesting to note that the type specimen of *M. jonkershoekensis* (PREM *44830*) was collected on *P. repens*, a species on which *M. proteae* has not yet been recorded.

The asci and ascospores of the new species (Fig. 10) are considerably smaller (32,0–57,2 × 10,2–15,9 μm and 11,2–20,7 × 3,9–7,6 μm) than those (Fig. 11) of *M. proteae* (52–100 × 16–25 μm and 17–30 × 5–9 μm) as reported in the literature (Winter, 1884; Sydow & Sydow, 1914; Doidge, 1921; Petrak, 1924; Müller & Von Arx, 1962). Our own measurements of the asci and ascospores of *M. proteae* on *P. neriifolia* (PREM *44816*) were 89,1–144,7 × 11,4–23,6 and 22,9–32,2 × 5,3–10,1 μm respectively. The ascospores of *M. jonkershoekensis* are also not as unequally one-septate as those of *M. proteae*. The lower cell of the ellipsoidal ascospores is only very slightly longer and narrower than the upper cell (Fig. 10), while this difference is conspicuous in the oblong-cuneate ascospores of *M. proteae* (Fig. 11).

The combination of morphological features of *M. jonkershoekensis* i.e. circular, sunken, necrotic leaf spots, smaller asci and ascospores and ellipsoidal, almost medially one-septate ascospores, clearly differentiates it from *M. proteae*, the only other species of *Mycosphaerella* known to occur on the genus *Protea*, and it is accordingly described as a new species.

ACKNOWLEDGEMENTS

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STUDIES IN THE GENERA OF THE *DIOSMEAE* (RUTACEAE): 6.

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Abstract

Acmadenia marlothii is transferred to the genus *Agathosma*. A new species of *Euchaetis* from the Piketberg is described. Two new species of *Acmadenia* from dry inland areas of the Cape Province, bordering on the Karoo, are described. A new species of *Diosma* from the mountains of the Little Karoo, formerly misidentified as *D. ramosissima*, is described. Four new species of *Diosma* from the coastal region between Walker Bay and Albertinia are described.

Uittreksel

STUDIES IN DIE GENERA VAN DIE *DIOSMEAE* (RUTACEAE): 6

Acmadenia marlothii word by *Agathosma* ingedeel. 'n Nuwe *Euchaetis* soort vanaf Piketberg word beskryf. Twee nuwe *Acmadenia* soorte uit die droë binneland aangrensend aan die Karoo word beskryf. Vier nuwe *Diosma* soorte van die kusstreek tussen Walkerbaai en Albertinia word beskryf.

Agathosma rudolphii Williams nom. nov. vice *Acmadenia marlothii* Dümmer in Ann. Bol. Herb. **3** (2): 86 (1921). Type: CAPE—3319 (Worcester): Matroosberg (-BC), 2 000 m, –11/– *Marloth 7948* (PRE, lectotype; BOL, fragment of type).

Specimens Examined

CAPE—3319 (Worcester): Matroosberg (-BC), 2 000 m (6 400 ft.), –/11– *Marloth* 7948 (PRE, BOL); Witteberg amongst rocks (-CA), 5 400 ft., 9/2/1943 *Esterhuysen 8678* (BOL); Du Toits Peak, n.w. slopes above gully (-CC), 6 000–6 500 ft., 26/1/1943 *Esterhuysen 8572* (BOL, NBG), 17/12/1972 *Myburgh 7* (STE); Wemmershoek Peak, gully on west side 5 000–5 793 ft., 31/12/1944 *Esterhuysen 11235* (BOL, GRA, K, NBG, SAM), 15/11/1968 *Jackson s.n.* (NBG), –/12/1944 *Stokoe s.n.* (SAM), –/12/1944 *Lewis s.n.* (SAM).

A close examination of material collected by Esterhuysen (No. 32094) and Myburgh (No. 7) has revealed several characters which exclude this plant from the genus *Acmadenia* and indicate that it should rather be placed in the genus *Agathosma* sensu Pillans: (1) the *flowers* are borne on slender terminal or axial branchlets; (2) *staminodes* 2,7 mm long, 0,7 mm broad, linear (not terete),

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glabrous, flat with an obtuse swollen apical gland; (3) *filaments* becoming 5,5 mm long, very sparsely villous towards the middle (not short and glabrous); (4) *pollen* 25 μ long, 17 μ diam. (much smaller than any in *Acmadenia*); (5) *disc* flat at the base of the ovary (does not surround the ovary); (6) *stigma* simple (not capitate); (7) *style* quite thick, at first completely deflexed, then more or less erect, 4 mm long, villous about the middle (not short and glabrous); (8) *ovary* and *fruit* 5-carpellate with short shovel-shaped apical processes (quite unlike any in *Acmadenia*).

This plant might have fitted very well into the genus *Barosma* but, as this genus has been sunk into *Agathosma*, it is now proposed that it be placed in *Agathosma* sensu Pillans. In doing so it is not possible to transfer the epithet *marlothii* to *Agathosma* without creating a homonym, consequently one of the christian names of Dr. H. W. R. Marloth, who discovered this plant, has been proposed as the new specific epithet.

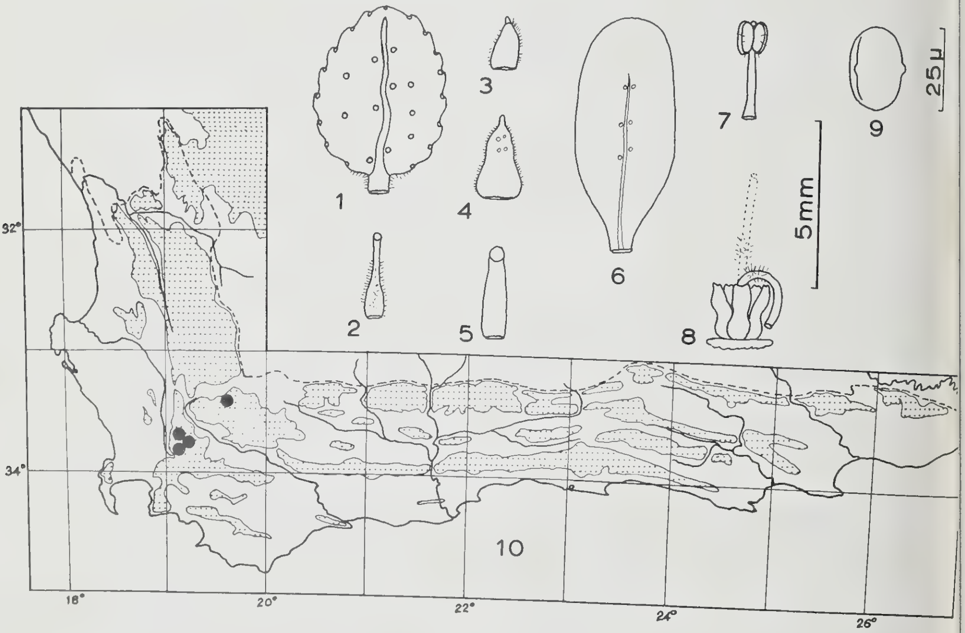

FIG. 1.

Agathosma rudolphii: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, staminode. 6, petal. 7, anther. 8, gynoecium. 9, pollen. 10, distribution. (Broken line shows northern limit of Cape geological system. Mountainous areas shown dotted.)

Euchaetis tricarpellata Williams sp. nov. propria propter fructum tricarpellatum.

Frutex ad 40 cm, ad basim monocaulis. *Rami* graciles, laevigati, erectiusculi. *Ramuli* erecti, graciles, glabri, foliis vestitis. *Folia* 5,5–7 mm longa, 1 mm lata, anguste lanceolata, acuta, mucronata, glabra, sub-glauca, eciliata, erecta, adpressa, alterna, brevissime petiolata. *Flores* c. 5 mm diam., terminales, 2–3 nati, albi. *Bractea* folio similis. *Bracteolae* duae, 3,3 mm longae, 1,2 mm latae, lanceolatae, acutae, mucronatae, glabrae, sub-glaucae, eciliatae, marginibus ad basim hyalinis. *Sepala* quinque, 4 mm longa, 2 mm lata, late lanceolata, acuta, glabra, glauca, eciliata, marginibus ad basim late hyalinis. *Petala* quinque, 6 mm longa, unguiculata, alba; *limbus* 3,5 mm longa, 3,5 mm lata, orbicularis, glaber, minute apiculatus; *unguis* 2,5 mm longus, 1,4 mm latus, transverse barbatus, ciliatus, ad basim translucidus. *Staminodia* quinque, 0,05 mm diam., vestigialia. *Filamenta* quinque, post anthesin, 1,5 mm longa, acicularia, glabra. *Antherae* quinque, ante anthesin 1,2 mm longae, 0,8 mm latae, vinosae, apicibus minute glandulosis. *Pollen* 45 μ longum, 23 μ diam., ellipsoideum. *Discus* ovarium ex parte includens, nectarifer. *Stigma* 0,5 mm diam., capitatum, globosum. *Stylus* post anthesin 1 mm longus, erectus, glaber, persistens. *Ovarium* 3-carpellatum, 0,7 mm diam., glabrum. *Fructus* 3-carpellatus, 9 mm longus, 4,5 mm diam., laevigatus, glaucus, in medio vinosus, *cornibus* 2 mm longis, erectis, emarginatis. *Semen* 4,1 mm longum, 2 mm latum, atrum, impolitum; *arilus* 1,5 mm longus, albus, acutus.

Type: CAPE—3218 (Clanwilliam): south from the summit of Versvelds Pass, Piquetberg (-DC), 640 m, 18/9/1972 *Williams 1690* (NBG, holotype).

This species was collected for the first time by Schlechter in 1894 and then again by Stokoe in 1941. After that it appears to have escaped notice until the author rediscovered it in 1972. Being a very inconspicuous plant, this is hardly to be wondered at and does not necessarily mean that it is rare on the Piquetberg when it occurs.

Shrubs up to 40 cm tall, inconspicuous, slender, diffuse, arising from a single stem at ground level. *Branches* slender, smooth, fairly erect. *Branchlets* erect, slender, glabrous, well clothed with leaves. *Leaves* 5,7–7 mm long, 1 mm broad, narrowly lanceolate, acute, mucronate, glabrous, sub-glaucous, indistinctly gland-dotted, eciliate, erect, adpressed, alternate, with a very short petiole. *Flowers* about 5 mm diam., terminal, white, 2–3 nate. *Bract* leaf-like. *Bracteoles* two, 3,3 mm long, 1,2 mm broad, lanceolate, acute, mucronate, glabrous, sub-glaucous, eciliate, margins below translucent. *Sepals* five, 4 mm long, 2 mm broad, broadly lanceolate, acute, glabrous, glaucous, eciliate, margins broadly translucent below. *Petals* five, 6 mm long, white, clawed; *limb* 3,5 mm long, 3,5 mm broad, orbicular, glabrous, minutely apiculate; *claw* 2,5 mm long, 1,4

mm broad, transversely bearded, ciliate, translucent towards the base. *Staminodes* five, 0,05 mm diam., vestigial. *Filaments* five, acicular, glabrous, after anthesis 1,5 mm long. *Anthers* five, before anthesis 1,2 mm long, 0,8 mm broad, wine coloured, with a minute rounded apical gland. *Pollen* ellipsoid, 45 μ long, 23 μ diam. *Disc* closes somewhat over the ovary, exudes nectar. *Stigma* 0,5 mm diam., capitate, globose, apex faintly 3-furrowed. *Style* becoming 1 mm long after anthesis, erect, glabrous, persisting. *Ovary* 3-carpellate, 0,7 mm diam., glabrous, the apices of the segments truncate. *Fruit* 3-carpellate, 9 mm long, 4,5 mm diam., smooth, glaucous, somewhat purplish about the middle; *horns* 2 mm long, erect, emarginate. *Seed* 4,1 mm long, 2 mm broad, black, not shining, with a pointed white aril 1,5 mm long.

SPECIMENS EXAMINED

CAPE—3218 (Clanwilliam): south from the summit of Versvelds Pass, Piquetberg (-DC), 640 m, 18/9/1972 Williams 1690 (NBG, holotype) 7/11/1974 *Williams 1917* (BOL); In planitis summum montis Piquetberg, 1 600 ft., 9/9/1894 *Schlechter 5244* (BOL, GRA); Kapteinskloof, Piquetberg, 25/9/1941 *Stokoe 8171* (BOL).

DISTRIBUTION, BIOLOGY AND VARIATION

Euchaetis tricarpellata occurs only on the mountains above Piquetberg in the South Western Cape at altitudes from 490 to 640 metres above sea level. It grows in hard quartzitic soil amongst rocks of the Table Mountain Series. Material that was both flowering and fruiting has been gathered in September and again in November. The presence of nectar in the flowers indicates that this plant is most likely to be pollinated by insects. The leaves, when crushed, have a smell of pine or cypress. Regeneration is by seed which is ejected in the usual way by a catapult mechanism. Isolated, as it is, on the Piquetberg, where this plant is the only representative of the genus *Euchaetis*, it is most unlikely that any variation or hybridisation will ever be found.

DISCUSSION

In the following respects this plant falls typically into the genus *Euchaetis*: (1) *petals* clawed and transversely bearded in the vicinity of the throat. These beards and the cilia of adjacent petals from a cage within which are found all the reproductive parts; (2) *staminodes* vestigial; (3) *anther* with a minute apical gland; (4) *disc* exceeds the ovary; (5) *stigma* capitate; (6) *style* short; (7) *filaments* and *style* glabrous. However, in one respect, the possession of a 3-carpellate ovary, this plant is unique in the genus. Northwards, in the Clanwilliam Division one finds *Euchaetis dubia* Sond. and to the south in the Cape and Malmesbury Divisions one finds *Euchaetis dubia* var. *dregeana* Sond. These species are plainly very closely related to *E. tricarpellata* but, amongst other things, they both have 4-carpellate ovaries. Sonder (1860) in describing *E. dubia* was somewhat hesitant in placing it in *Euchaetis* and Bentham and Hooker (1862–67) thought it should be transferred to *Macrostylis*. However, a close examination of *E. dubia* shows that it should remain in *Euchaetis* and that, quite possibly, it demonstrates an example of evolutionary reduction in the genus of which *E. tricarpellata* is but a further link.

Euchaetis tricarpellata is recognised as a distinct species because of its three-chambered ovary. It differs from *E. dubia* var. *dregeana* which has leaves and calyx lobes crisped ciliate and a 4-chambered ovary.

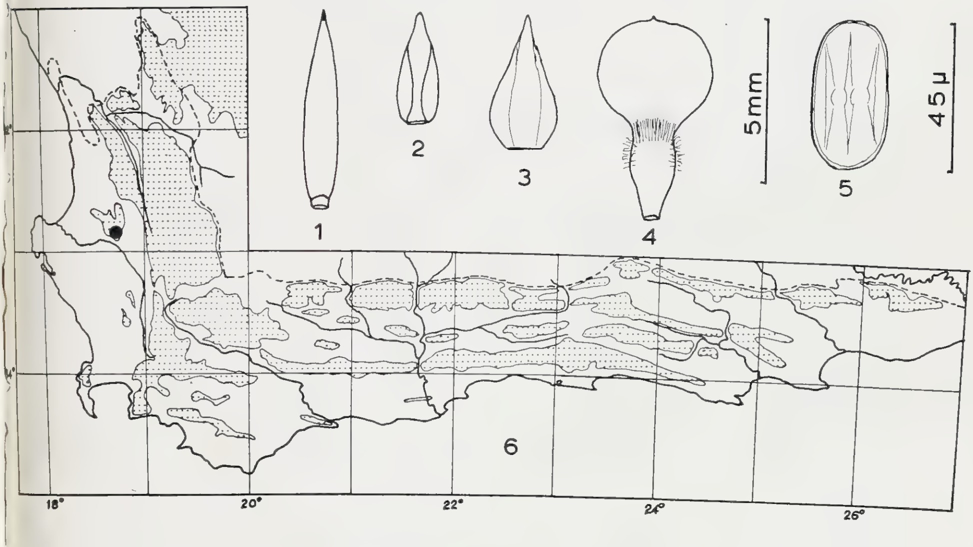

Fig. 2.

Euchaetis tricarpellata: 1, leaf. 2, bracteole. 3, calyx lobe. 4, petal. 5, pollen. 6, distribution.

Acmadenia fruticosa Williams sp. nov. propria propter fruticem fruticosum, foliis ellipticis parvis oppositis, flore 1 cm diam.

Frutex fruticosus, c. 80 cm, ad basim monocaulis. *Rami* brevi, glabri, erectiusculi, saepe dichotomi. *Ramuli* brevi, graciles, recti, puberuli, rubescenti. *Folia* 3–5 mm longa, 1,5–2 mm lata, elliptica, obtusa, breve petiolata, sparse puberula, glanduloso-punctata, costata, erecto-patens, opposita, decussata.

Inflorescentia terminalia, solitaria, 1 cm diam., alba vel sub-rosea. *Bracteae* duae, oppositae, 3,3 mm longae, 1,5 mm latae, unus similis foliis, alter marginibus ad basim hyalinis et ciliolatis. *Bracteolae* duae, 3 mm longae, 1,4 mm latae, oblangae, sub-acutae, ciliatae, extus sparsim puberulae, intus pubescentes, marginibus late hyalinis. *Sepala* quinque, 3 mm longa, 1,5–1,7 mm lata, oblonga, ciliata, apicibus acutis elevatis vinosis, marginibus late hyalinis, extus fere glabra, minute glanduloso-punctata, intus in medio pubescentia. *Petala* quinque, 7 mm longa, 2,8 mm lata, unguiculata, sub-roseus; *limbus* obovatus, obtusus, apiculatus, minute ciliolatus, in medio glanduloso-punctatus; *unguis* ad faucem inflexus sparsim puberulus, sparsim ciliolatus. *Staminodia* quinque, 1,2 mm longa, glabra, acicularis, apicibus glandulis coronatis. *Filamenta* quinque, post anthesin 2,3 mm longa, acicularia, glabra. *Antherae* quinque, ante anthesin 1,6 mm longae, 0,7 mm latae, flavidae, apicibus acute glandulosis. *Pollen* 39 μ longum, 26 μ diam., oblongum. *Discus* ovarium excedens, viridus, angustus, nectarifer. *Stigma* 0,7 mm latum, globosum, viridum, capitatum. *Stylus* post anthesim 1,3 mm longus, erectus, glaber, persistens. *Ovarium* 5-carpellatum, 0,75 mm diam., glabrum. *Fructus* 5-carpellatus, 7,5 mm longus, 4 mm diam., ad basim sepalis bracteisque obvallatus; cornibus erectis brevis. *Semen* 4,5 mm longum, 1,5 mm latum, piceum, nitens.

Type: CAPE—3321 (Ladismith): on the south side of road at the summit of Bosluiskloof Pass (-AD), 1 140 m (3 750 ft), Laingsburg Division, 12/7/1974 *Williams 1908* (NBG, holotype; C, GRA, K, M, MO, PRE, S, STE, isotypes).

This plant had been collected in the past by Esterhuysen, Wall and Halfstrom & Acocks and had remained undescribed until its rather unique appearance excited the author's curiosity. Attempts to locate it in the vicinity of Witteport were unsuccessful but, after seeing the collection by Halfstrom and Acocks amongst some material recently sent out for examination from Stockholm, the author was fortunate to be able to find a large and thriving population in the vicinity of the Bosluiskloof Pass. The description of this new species has been based upon this fresh material.

Shrubs about 80 cm tall, forming a dense bush with many branches arising from a single stem at ground level. *Branches* short, glabrous, fairly erect, often dichotomous. *Branchlets* short, slender, erect, puberulous, reddened. *Leaves* 3–5 mm long, 1,5–2 mm broad, elliptic, obtuse, margins thick, narrowed below to a short petiole, sparsely puberulous on all sides, with small gland-dots scattered mostly towards the prominent midrib, spreading-erect, opposite, decussate. *Inflorescence* terminal, solitary, 1 cm diam., white or pale pink. *Bracts* two, opposite, 3,3 mm long, 1,5 mm broad, one leaf-like, the other obovate, obtuse with the margins below translucent and ciliolate. *Bracteoles* two, 3 mm long, 1,4 mm broad, oblong, apex elevated, sub-acute and thick, midrib prominent, margins ciliate and broadly translucent below, outer surface sparsely puberulous, inner surface pubescent towards the middle. *Calyx lobes* five, 3 mm long, 1,5–1,7 mm broad, oblong, apex acute elevated wine-coloured, margins broadly translucent and ciliate, pubescent in the middle on the inner surface, minutely gland-dotted along the midrib and almost glabrous on the outer surface. *Petals* five, 7 mm long, 2,8 mm broad, clawed, pale pink or white; *limb* obovate, obtuse, apiculate, minutely ciliolate, gland-dotted towards the middle; *claw* bent inwards and sparsely puberulous at the throat, ciliolate. *Staminodes* five, 1,2 mm long, acicular, glabrous, apex glandular. *Filaments* five, becoming 2,3 mm long, erect, glabrous, acicular. *Anthers* five, before anthesis 1,6 mm long, 0,7 mm broad, yellow, with a pointed gland 0,2 mm long at the apex. *Pollen* 39 μ long, 26 μ diam., oblong. *Disc* exceeds the ovary, narrow, green, exudes nectar, without lobes. *Stigma* 0,7 mm broad, globose, capitate, green, sticky. *Style* becoming 1,3 mm long, erect, glabrous, persisting. *Ovary* 5-carpellate, 0,75 mm diam., glabrous, each carpel retuse with a submerged gland at the apex. *Fruit* 5-carpellate, 7,5 mm long, 4 mm diam., imbricated below by the persistent calyx lobes and bracts; *carpels* green, margins fringed with small hairs, with short erect purplish horns bifid at the apex with a gland in the centre. *Seed* 4,5 mm long, 1,5 mm broad, black, shining.

SPECIMENS EXAMINED

CAPE—3320 (Montagu): Witte Poort on sandstone hill, Ladismith/Laingsburg (-BD), –/5/1940 *Esterhuysen 1810* (BOL); Touwsberg, ridge on south slope (-DB), 2 000–3 000 ft., 1/6/1956 *Esterhuysen 25929* (BOL).

—— 3321 (Ladismith): Bosluiskloof Pass near Prince Albert (-AD), 14/11/1938 *Halfstrom* & *Acocks 787* (S); south side of the road at the summit of Bosluiskloof Pass, 1 140 m (3 750 ft.), 12/7/1974 *Williams 1908* (NBG, C, GRA, K, M, MO, PRE, S, STE), 14/11/1938 *Wall 55* (BOL). Note: *Wall 55* was previously cited in error under *Acmadenia sheilae* in Williams Studies No. 4, in Jl S. Afr. Bot. 40 (4): 281 (1974).

DISTRIBUTION, BIOLOGY AND VARIATION

Although *Acmadenia fruticosa* has only been collected in three localities it does occur so abundantly in the one examined by the author, at the summit of the Bosluiskloof Pass, that one feels that it must really be quite common. It appears to grow at altitudes of 600–1 200 m (2 000–4 000 ft.) above sea level on dry shallow quartzitic soil amongst brown rocks of the Table Mountain series. A section from the stem of a plant 80 cm tall, taken just above ground level, showed about 50 annual rings showing that this area had not been burnt for many years. Little is known about the flowering period but it probably extends over many months. The type collection made in July had flowers and fruits in all stages of development. The fact that the disc exudes nectar and that the style, bearing the stigma, lengthens only after the anthers have discharged their pollen indicates that this plant is most probably pollinated by insects. Regeneration is only from seed which is ejected as soon as ripe by the usual catapult mechanism. The leaves when crushed have a rather weak resinous smell.

Variation in *Acmadenia fruticosa* has been observed. Specimens from Witte Poort about 60 km west of Bosluiskloof Pass are found to have leaves with gland-dots on the margins as well as towards the midrib, petals somewhat smaller, 4,6 mm long, 1,5 mm broad and staminodes shorter, 0,8 mm long.

DISCUSSION

This plant appears to be a typical *Acmadenia* mainly because: (1) the *petals* are clawed and bent inwards at the throat, and (2) *staminodes* are present with a pointed gland at the apex. Other factors which exclude other genera of the *Diosmeae* are: (3) *anther* with a small pointed gland; (4) *disc* exceeds the ovary; (5) *stigma* capitate; (6) *style* short, erect; (7) *filament* and *style* glabrous; (8) *ovary* 5-carpellate.

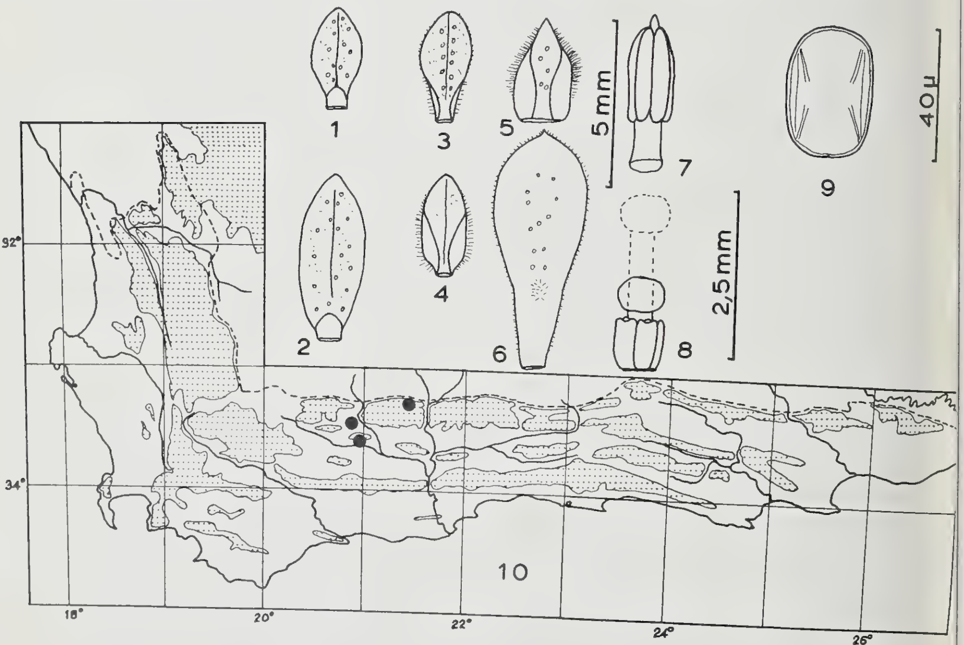

FIG. 3.
Acmadenia fruticosa: 1, small leaf. 2, large leaf. 3, bract. 4, bracteole. 5, calyx lobe. 6, petal. 7, anther. 8, gynoecium. 9, pollen. 10, distribution.

Acmadenia fruticosa is recognised as distinct because of having small elliptic leaves and smallish pale pink flowers 1 cm diam. Several other species of *Acmadenia*, namely *A. laxa* Williams, *A. macropetala* (Glover) Compton, *A. niveni* Sonder, *A. obtusata* (Thunb.) Bartl. & Wendl., *A. sheilae* Williams and *A. tetragona* (L.f.) Bartl. & Wendl. have a similar arrangement of opposite leaves and obvallate bracts at the base of the fruit. They are all however easily recognised as distinct from *A. fruticosa* here described. The name is an allusion to the very dense bushy habit of the plant.

Acmadenia tetracarpellata Williams sp. nov. propria propter fructum 4-carpellatum.

Frutex fruticosus, 50 cm altus, 1 m diam., ad basim monocaulis. *Rami* numerosi, sub-dichotomi, erectiusculi, glabri, intertexti. *Ramuli* numerosi, erectiusculi, graciles, sparsim puberuli, aliquot glanduloso-punctati. *Folia* 3 mm longa, 1,5–2,5 mm lata, elliptica vel orbicularia, obtusa, crassa, apice immerso-glanduloso, marginibus crassis glanduloso-punctatis, costa disperso-glanduloso-punctata, tota sparsim puberula, sub-glauca, sessilia, opposita, patentia, decussata. *Inflorescentia* 2-nata, terminalia, inconspicua. *Bracteae* folia similis, duae, oppositae, 1,5 mm longae, 1,3 mm latae, orbiculares, puberulae, crassae, sessiles, patentes, costa glanduloso-punctata, apice tumido-immerso-glanduloso. *Bracteolae* duae, 0,7 mm longae, 0,5 mm latae, orbiculares, crassae, ciliolatae, totae sparsim puberulae, apice immerso-glanduloso. *Sepala* quinque, 1,2 mm longa, 0,7–0,8 mm lata, oblonga, obtusa, minute ciliolata, minute puberula, sparsim glanduloso-punctata. *Petala* quinque, 2 mm longa, 0,9 mm lata, lanceolata, obtusa, intus ad basim extusque sparsim pubescentia, sessilia, patentia, marginibus revolutis serrulatis. *Staminodia* quinque, 0,3–0,5 mm longa, ad apices glandulosa. *Filamenta* quinque, post anthesin 1,2 mm longa, acicularia, glabra. *Antherae* quinque, ante anthesin 0,7 mm longae, 0,5 mm latae, roseo-flavae, apicibus sessili-glandulosis. *Pollen* 40 μ longum, 20 μ diam., oblongum. *Discus* viridus, sub-sinuatus, ovarium aequans, nectarifer. *Stigma* 0,2 mm diam., capitellatum, globosum. *Stylus* primum deflexus deinde erectus, 0,8 mm longus, glaber, teres. *Ovarium* 4-carpellatum, 0,7 mm diam., glabrum. *Fructus* pleurumque 4-carpellatus, 5 mm longus, 4 mm diam., rubescens, glanduloso-punctatus, sparsim puberulus, cornibus 1,5 mm longis erecto-patentibus. *Semen* 3,2 mm longum, 1,5 mm latum, piceum, nitens.

Type: CAPE—3219 (Wupperthal): in sandy soil below small cliffs, Groenfontein, Swartruggens, Ceres Division (-DC), 1 220 m (4 000 ft.), 20/11/1974 *Williams 1928* (NBG, holotype; BOL, K, M, MO, PRE, S, STE, isotypes).

Acmadenia tetracarpellata was discovered by Miss Elsie Esterhuysen of the Bolus Herbarium in 1961. No further collections were made until 1974 when the author, following Miss Esterhuysen's directions, was able to make the collection on which this description is based.

Shrubs 0,5 m tall, spreading 1 m diam., dense, light green in colour, the lower branches becoming buried in sand, single stemmed at base. *Branches* numerous, stout at base, sub-dichotomous, somewhat spreading, very much interwoven, glabrous with a greyish brown fairly rough bark. *Branchlets* very numerous, slender, fairly erect, sparsely puberulous, with a few gland-dots. *Leaves* 3 mm long, 1,5–2,5 mm broad, elliptic or orbicular, obtuse, thick, apex with a blunt immersed gland, margins thick and gland-dotted, midrib with scattered gland-dots, sparsely puberulous on all sides, sub-glaucous, sessile, opposite, spreading, decussate, often widely spaced on the uppermost branchlets. *Inflorescence* 2-nate, terminal, white, inconspicuous. *Bracts* leaf-like in opposite pairs, 1,5 mm long, 1,3 mm broad, orbicular, puberulous, thick, sessile, spreading, apex curiously swollen with a submerged gland, midrib gland-dotted. *Bracteoles* two, 0,7 mm long, 0,5 mm broad, orbicular, thick, ciliolate, sparsely puberulous on both sides with a single gland-dot at the apex. *Calyx lobes* five, 1,2 mm long, 0,7–0,8 mm broad, oblong, obtuse, minutely ciliolate, minutely puberulous, with one or two small gland-dots on the midrib and at the apex. *Petals* five, 2 mm long, 0,9 mm broad, lanceolate, obtuse, sessile, spreading, white, very sparsely pubescent on the abaxial surface and on the inner surface towards the base, margins serrulate and revolute. *Staminodes* five, 0,3–0,5 mm long, apex glandular. *Filaments* five, glabrous, acicular, becoming 1,2 mm long. *Anthers* five, before anthesis 0,7 mm long, 0,5 mm broad, yellow tinged with pink, with a minute sessile apical gland. *Pollen* 40 μ long, 20 μ diam., oblong. *Disc* green, sub-sinuate, equals or exceeds the ovary, exudes nectar. *Stigma* 0,2 mm diam., capitellate, globose. *Style* glabrous, terete, at first deflexed becoming 0,8 mm long. *Ovary* 4-carpellate, 0,7 mm diam., glabrous. *Fruit* normally 4-carpellate, 5 mm long, 4 mm diam., reddened, gland-dotted, very sparsely puberulous, with *horns* 1,5 mm long, puberulous, with an immersed gland at the apex, spreading at 45°, petals and style persisting. *Seed* 3,2 mm long, 1,5 mm broad, black, shining.

SPECIMENS EXAMINED

CAPE—3219 (Wupperthal): in sandy soil below small cliffs, Groenfontein, Swartruggens, Ceres Division (-DC), 1 220 m (4 000 ft.), 20/11/1974 *Williams 1928* (NBG, BOL, K, M, MO, PRE, S, STE); in sand on slopes of valley below cliffs, Stompiesfontein, Swartruggens, Ceres Division, 3 500 ft., 18/11/1961 *Esterhuysen 29330* (BOL).

DISTRIBUTION, BIOLOGY AND VARIATION

Acmadenia tetracarpellata appears to be a fairly rare plant having only been collected on the farm Groenfontein lying in the Swartruggens. This is a dry elevated plateau about 4 000 feet above sea level consisting of quartzitic sandstone rocks of the Witteberg series interspersed with sandy plains, with rain falling mainly in the winter months.

The minute white flowers, wide open exposing the nectariferous disc, are most probably insect pollinated. The seeds when ripe are ejected by the usual catapult mechanism and regeneration is most probably possible only from seed. A section of the stem of one plant at ground level, 2 cm diam., showed at least 30 annual rings, showing that fires seldom occur. No seedlings were seen. It is therefore presumed that regeneration from seed may take place only after fire has cleared the ground. The leaves when crushed are aromatic with a faint scent of mint or lemon.

Branchlets, leaves, bracts and fruits on the plant collected by Esterhuysen are glabrous instead of minutely puberulous. This sort of variation has been seen to occur in other species in the *Diosmeae*. Of 50 fruits examined 2 were found to be 5-carpellate and 1 was found to be 3-carpellate. They were all from the same population. Often in the *Diosmeae* one finds that one or two carpels are not fertilised and so do not develop. This condition is easily observed as the aborted segment is quite visible. This is quite a different condition from the variation mentioned above which is due to the genic make-up inherent in the plant and in this case appears to represent reduction taking place from a 5-carpellate ancestral population. The extremely arid conditions under which these plants live may be the reason for all other forms of reduction observable in this species when compared with *Acmadenia fruticosa* and *Acmadenia sheilae*. In this series of fairly similar plants all parts show a stepped reduction in size enabling them to be described as distinct species.

Discussion

Although the flower of this plant with its wide open petals exposing the disc looks at first rather like a *Diosma*, the presence of staminodes attached at the outer base of the disc adjacent to the petals, the shape of the disc itself, closely surrounding the ovary not open and crenulate, and the obvious resemblance of the whole plant to *Acmadenia fruticosa* leads one to place it in the genus *Acmadenia*. *A. matroosbergensis* is another plant in this genus which agrees with *A. tetracarpellata* in many ways, including the size and positioning of the staminodes. Other factors which exclude this plant from other genera of the *Diosmeae* are: (1) *petals* without any transverse beard; (2) *staminodes* present; (3) *anther* with a small apical gland; (4) *stigma* capitellate; (5) *style* short; (6) *filament* and *style* glabrous.

Acmadenia tetracarpellata is recognised as distinct on account of its having extremely small open flowers and being the only plant in the genus with a 4-carpellate ovary, as the name signifies.

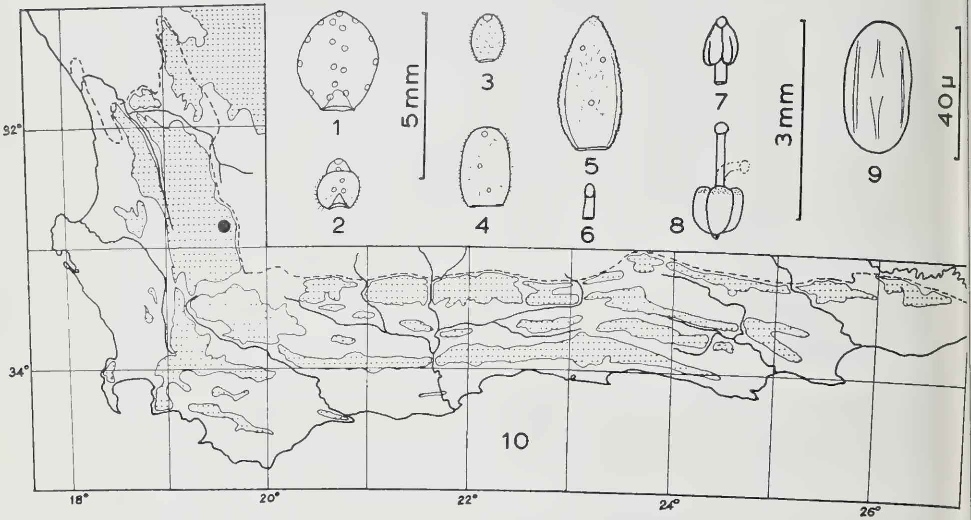

FIG. 4.

Acmadenia tetracarpellata: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, petal. 6, staminode. 7, anther. 8, gynoecium. 9, pollen. 10, distribution.

Diosma prama Williams sp. nov. propria propter ramulos paene glabros, folia glanduloso-pustulata praecipue versus costam, sepala glanduloso-pustulata sine callo apicali, petala glabra, stylum erectum, staminodia 0,2 mm longa.

Frutex ad 1,5 m, erectus, ad basim monocaulis. *Rami* erecti, glabri, dichotomi. *Cortex* laevis. *Ramuli* brevissimi, erecti, paene glabri. *Folia* 3–4,5 mm longa, 1,2-1,4 mm lata, oblonga, obtusa, glabra, eciliata, glanduloso-pustulata praecipue versus costam, erecta, adpressa, sessilia, alterna. *Inflorescentia* terminalia, 1-vel 2-nata, sessilia, 5 mm diam., eburnea. *Bractea* 1,1 mm longa, 0,8 mm lata, deltoidea, crassa, obtusa, glabra, glanduloso-pustulata, adpressa. *Bracteolae* duae, 1 mm longae, 0,7 mm latae, oblongae, obtusae, crassae, glabrae, glanduloso-pustulata, ad basim sparsim ciliolatae. *Sepala* quinque, 1,2 mm longa, 1,2 mm lata, ovata vel sub-orbiculares, apicibus incrassatis, ciliolata, extus glabra, glanduloso-pustulata, intus pubescentia. *Petala* quinque, 2,2 mm longa, 1,5 mm lata, oblonga, sessilia, glabra, patens, eburnea. *Staminodia* quinque, 0,2 mm longa, 0,1 mm diam. *Filamenta* quinque, post anthesin 1 mm longa, glabra. *Antherae* quinque, ante anthesin 0,8 mm longae, 0,7 mm latae, luteae,

apicibus minute glandulosis. *Pollen* c. 43 μ longum, 25 μ diam., oblongum. *Discus* 5-sinuato-crenulatus, patens, viridus, nectarifer. *Stigma* 0,3 mm diam., capitellatum. *Stylus* 0,8 mm longus, glaber, erectus. *Ovarium* 5-carpellatum, 0,9 mm diam., glabrum. *Fructus* 5-carpellatus, 7 mm longus, 6 mm diam., cornibus brevibus patens. *Semen* c. 6,3 mm longum, 2,5 mm latum, piceum, nitens.

Type: CAPE—3321 (Ladismith): north side of Rooiberg Pass (-CC), 570 m (1 850 ft.), 12/7/1974 *Williams 1905* (NBG, holotype; BOL, C, K, M, MO, PRE, S, STE, isotypes).

Diosma prama from the Little Karoo, has been collected many times in the past and has always been mis-identified as *Diosma ramosissima* Bartl. & Wendl. a species to which it has a superficial resemblance. It was only fairly recently with the publication in *Taxon* of an article by Gerhard Wagenitz (1972) on the Wendland herbarium, now in Göttingen, that it became possible to actually inspect the type material of *Diosma ramosissima* Bartl. & Wendl. and to compare it with specimens recently collected by the author from near Clanwilliam. As a result of this it became clear that the plant here described differed in several respects and it is now accordingly described as a new species. *D. prama* was apparently collected for the first time by Harry Bolus in 1904 between Garcias Pass and Muiskraal.

Shrubs up to 1,5 m tall, rigidly erect, fairly diffuse, arising from a single stem with a maximum diameter of about 3 cm at the base, standing above the general level of the vegetation. *Branches* erect, glabrous, dichotomous, with a fairly smooth bark. *Branchlets* on mature plants very short, erect, virtually glabrous, well clothed with leaves but soon becoming leafless. *Leaves* 3–4,5 mm long, 1,2–1,4 mm broad, oblong, obtuse, eciliate, glabrous, erect, adpressed, sessile, alternate, with pustulate gland-dots scattered mainly towards the midrib. *Inflorescence* terminal, 1- or 2-nate, sessile, 5 mm diam., yellow in bud, cream when open displaying the cup filled with nectar and the red-tipped staminodes on the lobes of the disc. *Bract* 1,1 mm long, 0,8 mm broad, deltoid, thick, obtuse, glabrous, appressed, with pustulate gland-dots, sparsely ciliolate below. *Bracteoles* two, 1 mm long, 0,7 mm broad, oblong, obtuse, thick, glabrous, margins narrow, ciliolate below, pustulate with gland-dots. *Calyx lobes* five, 1,2 mm long, 1,2 mm broad, ovate or sub-orbicular, thickened at the apex, glabrous, margins translucent, ciliolate, pustulate with gland-dots towards the midrib on the outside, pubescent inside. *Petals* five, 2,2 mm long, 1,5 mm broad, oblong, glabrous, sessile, cream coloured, spreading. *Staminodes* five, 0,2 mm long, 0,1 mm diam., apices reddened. *Filaments* five, becoming 1 mm long, glabrous, acicular. *Anthers* five, before anthesis 0,8 mm long, 0,7 mm broad, yellow, apical gland 0,2 mm diam. *Pollen* about 43 μ long, 25 μ diam., oblong. *Disc* 5-sinuate-crenulate, stands open, exceeds the ovary, green, exudes nectar. *Stigma* 0,3 mm diam., capitellate, 5-lobed at first becoming globose, green, sticky. *Style* becoming 0,8 mm long, glabrous, erect. *Ovary* 5-carpellate, 0,9 mm diam., glabrous, apex of each carpel with a large translucent gland. *Fruit* (from *Williams 1575*) 5-carpellate, 7 mm long, 6 mm diam., *carpels* reddened with *horns* green, short, spreading, rather thickened at the apex, sometimes recurved with the apical gland now on the under side. *Seed* (from *Williams 1575*) 6,3 mm long, 2,5 mm broad, black, shining.

SPECIMENS EXAMINED

CAPE—3320 (Montagu): Touwsberg, S. slopes of ridge (-DB), 3 000–4 000 ft., 1/6/1956 *Esterhuysen 25902* (BOL).

—— 3321 (Ladismith): Near Bosluis Pass, Swartberg, N. foothills, stony hilltop (-AD), 10/10/1960 *Esterhuysen 28254* (BOL); Dry stony summit of the Paardeberg at the head of Huis River Pass (-BC), 23/5/1950 *Esterhuysen 17113* (BOL, LD); Gamka Pass near Calitzdorp, sandstone summit and slopes, 24/5/1950 *Esterhuysen 17134* (BOL, NBG); In plains at the summit of the road between Garcias Pass and Muiskraal (-CC), –/10/1904 *H. Bolus 11240* (BOL); Garcias Pass, 9/8/1949 *Morris 241* (BOL, NBG); N. side of Garcias Pass, 1 700 ft., 8/12/1938 *Wall s.n.* (LD); on hill above Muiskraal, Garcias Pass, 1 900 ft., 23/12/1971 *Williams 1614* (NBG); Waterval, 15 m. E. of Garcias Pass on N. slopes of Langeberg (-CD), 1 800 ft., 1/10/1923 *Muir 2913* (BOL, GRA); Roodeberg (-DA), 4 500 ft., 1/11/1931 *Compton 3846* (BOL, NBG), 5 000 ft., 1/11/1941 *Compton 3922* (BOL, NBG), 4 000 ft., –/3–1940 *Lewis 1754* (SAM), 24/3/1940 *Compton 8661* (NBG); Roodeberg Pass near summit c. 3 000 ft., 19/7/1954 *Stokoe s.n.* (SAM); Rooiberg Pass, N. side and S. side 2 000 –2 500ft., 30/10/1971 *Williams 1575* (NBG); N. side of Rooiberg Pass, 1 850 ft. (570 m), 12/7/1974 *Williams 1905* (NBG, BOL, C, K, M, MO, PRE, S, STE).

—— 3322 (Oudtshoorn): Slopes above Meirings Poort, S. aspect (-BC), 16/10/1955 *Esterhuysen 24843* (BOL); N. foot of Outeniquas near Moeras River (-CC), 2/12/1951 *Esterhuysen 19442* (BOL, NBG); Klein Moeras Rivier Spruiten, 6/12/1951 *Barker 7718* (BOL, NBG); Kruis Pad, N. of Moeras Rivier, 24/11/1949 *Compton 21760* (NBG); Langkloof hills, N. of Eensaamheid, on road to Buffelsdrif (-DD), 2 550 ft., 14/8/1971 *Williams 1508* (NBG).

—— 3323 (Willowmore): Top of pass between Avontuur and Uniondale (-CA), 3 500 ft., –/3/1922 *Fourcade 2904* (BOL, GRA); Hoopsberg summit (-CB), 6 200 ft., 6/11/1941 *Esterhuysen 6541* (BOL); 4 miles N. of Ongelee P.O., 2 400 ft., 16/11/1958 *Acocks 20000* (BOL); Ongelegen, 31/1/1941 *Esterhuysen 4695* (BOL, GRA); Kouga Mts., peak E. of Smutsberg, lower shaly slopes (-DB), 27/11/1941 *Esterhuysen 7027* (BOL); Kouga Mts., lower slopes near Smutsberg, E. aspect, 12/11/1944 *Esterhuysen 10728* (BOL); Kouga, 29/11/1941 *Esterhuysen 4688* (BOL, GRA, SAM), 20/12/1933 *Compton 4586*

(BOL, NBG), 29/1/1941 *Compton 10522* (NBG); near Joubertina (-DD), 2/5/1935 *Compton 5208* (BOL, NBG), 23/7/1942 *C. J. Esterhuysen s.n.* (BOL, NBG).

—— 3424 (Steytlerville): Baviaanskloof, hillside above kloof (-CB), 21/10/1955 *Esterhuysen 24992* (BOL), 21/10/1955 *Esterhuysen 25004* (BOL); Cambria, Humansdorp Division, 13/4/1952 *Compton 23471* (NBG), 13/4/1952 *Compton 23484* (NBG); Cambria Pass, Humansdorp Division, 26/4/1953 *Compton 24083* (NBG); Plateau 10 miles W. of Cambria, 2 000 ft., 29/4/1947 *Story 2451* (GRA); Kouga hills, Sewefontein, Humansdorp Division (-CC), 12/11/1941 *Esterhuysen 6700* (BOL); Guerna Kop, S. slopes above drift on Koega River (-CD), 700 ft., 2/5/1972 *Rourke 1323* (NBG, STE); Cockscomb, Winterhoek Mts., rocky kloof and ridge on N. slopes (-DB), 2 000–3 000 ft., 2/2/1958 *Esterhuysen 27488* (BOL), 30/11/1958 *Esterhuysen 27988* (BOL).

Distribution, Biology and Variation

Diosma prama has so far been found distributed over a wide area from the Touwsberg in the west to the Cockscomb Mountain in the east, a distance of about 350 km (220 miles) and at altitudes varying from 210 m (700 ft.) at Guerna Kop up to 1 700 m (5 600 ft.) on the summit of the Hoopsberg. It is found in mountainous country growing on hard dry stony or rocky ground derived from the Table Mountain series. It has been collected in every month of the year except September and would therefore appear to have a very extended flowering period. However, a few fruits may be seen from July onwards reaching a peak about the end of October so that perhaps the peak of the flowering season may occur in June or July. The wide open flower, with its cup of nectar and its pollen ripening before the style lengthens would indicate that this plant is most probably insect pollinated. In fact, when collecting the type material in July, bees (*Apis mellifera*) were observed to be visiting the flowers. As the plant, quite plainly, does not coppice from the root, regeneration is possible only from seed which is dispersed when ripe in the usual manner by a catapult mechanism.

The leaves when crushed have a rather faint resinous smell. They have a light green colour making the plant quite conspicuous amongst the other vegetation. One stem 18 mm in diam., showed about 25 rings. The largest plant seen had a stem about 30 mm in diam., so that the veld in this part of Rooiberg Pass had clearly not been burnt for perhaps 50 years.

With such a large area of distribution one might expect to find some variation in this species. This becomes apparent towards the eastern limit of the range where populations are found to have somewhat larger leaves that are also slightly more spreading, more or less forming a cline. This difference may be entirely due to a change in the rainfall pattern, the smaller adpressed leaves indicating dryer conditions in the west and the slightly spreading leaves the more humid conditions in the east.

DISCUSSION

The wide open flower enables one to see at once that this plant should be placed in the genus *Diosma* L. Other criteria which exclude other genera of the *Diosmeae* are:

(1) *Petals* clawless, sessile, patent. (2) *Staminodes* minute. (3) *Anther* with a small spherical apical gland. (4) *Disc* 5 sinuate crenulate, stands open, exceeds the ovary. (5) *Stigma* capitellate. (6) *Style* short. (7) *Filament* and *style* glabrous. (8) *Ovary* 5-carpellate.

Diosma prama is recognised as a distinct species because of its having branchlets virtually glabrous, leaves with pustulate gland-dots scattered mainly towards the midrib, calyx lobes pustulate with gland-dots but without any apical callus, petals glabrous, style erect and staminodes 0,2 mm long. It differs from

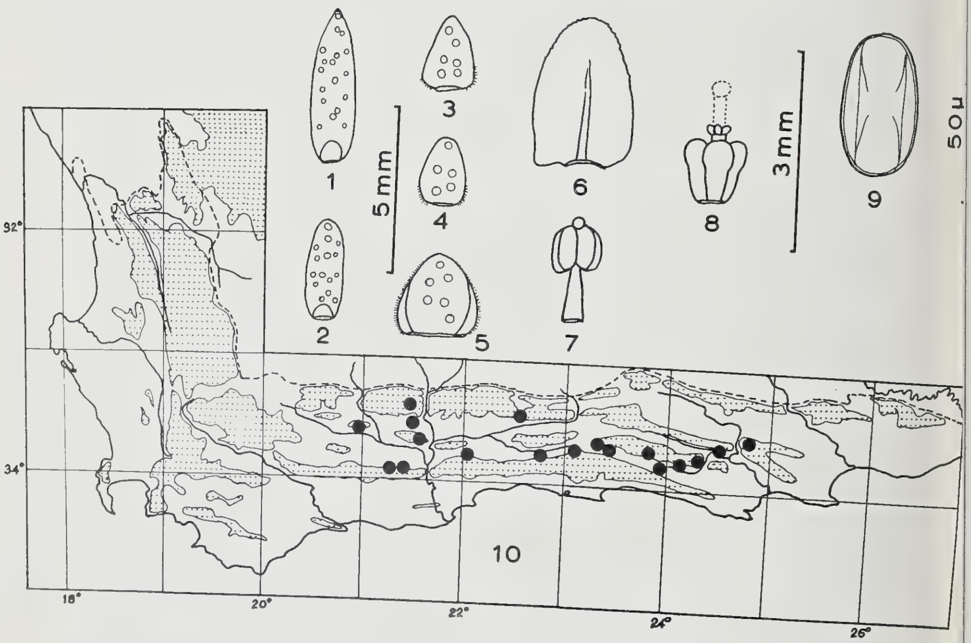

FIG. 5.

Diosma prama: 1, leaf. 2, leaf. 3, bract. 4, bracteole. 5, calyx lobe. 6, petal. 7, anther. 8, gynoecium. 9, pollen. 10, distribution.

D. ramosissima Bartl. & Wendl. which has a closely spaced row of gland-dots on either side of the midrib of the leaf, branches, leaves and petals puberulous and no staminodes. It differs also from *D. passerinoides* Steud. which has branchlets puberulous, leaves with one or two gland-dots on the margins as well as on the midrib, calyx lobes without gland-dots but with an apical callus and staminodes vestigial. The epithet *prama* is a telescoping of the rather unwieldy name *p*seudo*ra*mosissi*ma* indicating the confusion that formerly existed in identifying these species.

Diosma awilana Williams sp. nov. propria propter folia late lanceolata reflexo-mucronata crispo-ciliata alterna sessilia, staminodia carens, ovarium glabrum.

Frutex ad 1–2 m, erectus, ad basim monocaulis. *Cortex* satis levigata. *Rami* erecti, glabrescenti. *Ramuli* erecti, breviores, pubescenti, foliosi. *Folia* 5 mm longa, 3,3 mm lata, ovata vel late lanceolata, acuta, reflexo-mucronata, crispo-ciliata, glabra, sessilia, alterna, erecta, sub-complicata, glanduloso-punctata. *Inflorescentia* terminalia, 1–4 aggregata. *Bractea* 3,5 mm longa, 1,7 mm lata, lanceolata, acuta, mucronata, crispo-ciliata, glabra, glanduloso-punctata. *Bracteolae* duae, 2 mm longae, 0,7 mm latae, lanceolatae, acutae, mucronatae, ciliatae, glabrae. *Sepala* quinque, 2,3 mm longa, 1,8 mm lata, late-lanceolata, acuta, mucronata, glabra, marginibus hyalinis ciliatis. *Petala* quinque, 2,9 mm longa, 2 mm lata, orbicularia, glabra, sessilia, minute apiculata, sparsim ciliolata. *Staminodia* carens. *Filamenta* glabra, acicularia, post anthesin 2 mm longa. *Anthereae* quinque, ante anthesin 0,8 mm longae, 0,7 mm latae, aurantiaca, apicibus minute glandulosis. *Pollen* 60 μ longum, 28 μ diam., ellipsoideum. *Discus* 5-sinuato-crenulatus, patens, 2 mm diam., ovarium excedens, nectarifer. *Stigma* 0,2 mm diam., capitellatum, viridum. *Stylus* glaber, primo deflexus, deinde erectus, 2 mm longus. *Ovarium* 5-carpellatum, 0,7 mm diam., glabrum. *Fructus* 5-carpellatus, 12 mm longus, glaber, multi-glanduloso-punctata, oleosus, cornibus 5 mm longis erectis. *Semen* 5,3 mm longum, 2,8 mm latum, piceum, nitens.

Type: CAPE—3419 (Caledon): at base of limestone hills, Awila south of Baardscheerdersbosch, Bredasdorp Division (-DA), 61 m (200 ft.), 25/5/1973 *Williams 1803* (NBG, holotype; PRE, STE, MO, K, isotypes).

Diosma awilana appears to have been first collected by Compton in 1946 and then by Barker and Lewis in January 1948 and then again by Lewis and Martin in June 1950. These localities were given different names but there is little doubt that they all refer to the same locality on, and near, the farm Awila where this species is still to be found.

Shrubs up to 1,2 m tall, erect, arising from a single stem at base. *Branches* erect, glabrescent, arising in clusters, with a fairly smooth bark. *Branchlets* erect, fairly short, pubescent, well clothed with leaves. *Leaves* up to 8 mm long, 4,7 mm broad, normally about 5 mm long, 3,3 mm broad, ovate or broadly-lanceolate, acute, apex abruptly recurved with a sharp point, hyaline margins narrow, crisped ciliate, glabrous, sessile, alternate, erect, sub-complicate, gland-dotted along the blade on either side of the midrib. *Inflorescence* terminal, 1–4 aggregate, flowers opening in succession. *Bract* 3,5 mm long, 1,7 mm broad, leaf-like, lanceolate, acute, mucronate, crisped ciliate, glabrous, gland-dotted on either side of the midrib. *Bracteoles* two, 3 mm long, 0,7 mm broad, lanceolate, asymmetrical in outline, acute, mucronate, ciliate, glabrous. *Calyx lobes* five, 2,3 mm long, 1,8 mm broad, broadly lanceolate, acute, mucronate, apex pink in colour, glabrous, ciliate with broad translucent margins. *Petals* five, 2,9 mm long, 2 mm broad, orbicular, glabrous, minutely apiculate, sessile, sparsely ciliolate. *Staminodes* absent. *Filaments* five, glabrous acicular, becoming 2 mm long. *Anthers* five, before anthesis 0,8 mm long, 0,7 mm broad, yellow tinged with pale red, apical gland minute and sessile. *Pollen* 60 μ long, 28 μ diam., ellipsoidal, slightly contracted in the middle. *Disc* 5-sinuate-crenulate, spreading, 2 mm diam., green, exudes nectar, exceeds the ovary by a long way. *Stigma* 0,2 mm diam., capitellate, green. *Style* glabrous, at first deflexed finally becoming erect and nearly 2 mm long. *Ovary* 5-carpellate, 0,7 mm diam., glabrous. *Fruit* 5-carpellate, 12 mm long, glabrous, oily when fresh with many gland-dots, with horns 5 mm long, erect. *Seed* 5,3 mm long, 2,8 mm broad, black, shining.

SPECIMENS EXAMINED

CAPE—3419 (Caledon): limestone hills near Gansbaai (-DA), –/1/1948 *Lewis 3093* (SAM); Baardscheedersbos, Bredasdorp Division, 25/1/1948 *Barker 5306* (NBG); Hagelkraal, near Danger Point on limestone hills, –/6/1950 *Lewis 3369* (SAM); Havenga's farm near Strandskloof, Bredasdorp Division, 12/6/1950 *Martin 352* (BOL, NBG); at base of limestone hills, Awila south of Baardscheerdersbos, Bredasdorp Division, 61 m (200 ft.), 29/8/1971 *Williams 1514* (NBG), 25/5/1973 *Williams 1803* (NBG, PRE, STE, MO, K); Witkoppies near Dassieshoek on road to Awila, Bredasdorp Division (-CB), 150 ft., 2/8/1973 *Williams 1835* (NBG), Hagelkraal, limestone hills, Bredasdorp Division, 28/12/1946 *Compton 19037* (NBG).

DISTRIBUTION, BIOLOGY AND VARIATION

Diosma awilana appears to be confined to a fairly small area along the southern base of the range of limestone hills to the south of Baardscheedersbos village. The plants grow at an altitude of 45 to 61 m (150–200 ft.) above sea level in deep sandy soil with very little humus. Flowering material has been collected in January and May and fruiting material in August. The presence of nectar in the wide open flower would indicate that this plant is insect pollinated. When ripe the seed is ejected by the usual catapult mechanism and regeneration takes place only after fires which clear the ground of its cover of vegetation. The leaves when crushed are not very strong smelling. No variation has been noted in this relatively rare species.

The following characters indicate firstly that this species should be placed in the genus *Diosma* and furthermore help to exclude it from other genera of the *Diosmeae*: (1) The *flower* stands wide open with the *petals* sessile; (2) *staminodes* absent; (3) *anther* with a minute apical gland; (4) *disc* 5-sinuate-crenulate, exceeds the ovary, spreads open; (5) *stigma* capitellate; (6) *style* short; (7) *style* and *filaments* glabrous; (8) *ovary* 5-carpellate.

Diosma awilana is recognised as distinct on account of its having alternate leaves, sessile, broadly lanceolate with the mucro sharply reflexed and margins crisped ciliate; without any staminodes and with the ovary glabrous. It is probably most closely related to *Diosma subulata* which occurs both to the west near Walker Bay and to the east along the base of the Soetanysberg and at

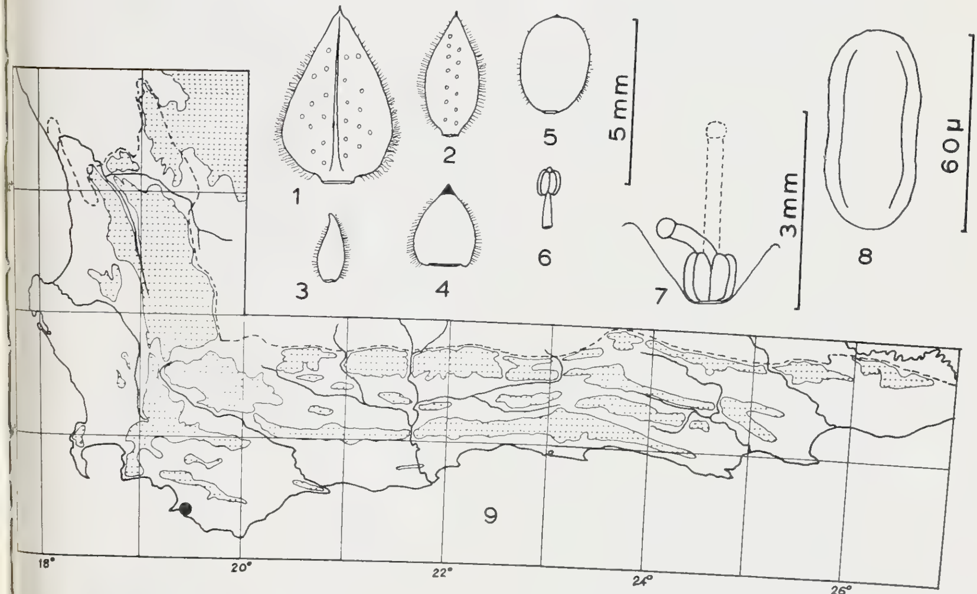

FIG. 6.

Diosma awilana: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, petal. 6, anther. 7, gynoecium. 8, pollen. 9, distribution.

Cape Agulhas. *D. subulata* however has leaves that are frequently opposite, petiolate and falcate with a straight point. It also differs from *Diosma sabulosa*, which occurs much further to the east from the Potberg to Albertinia, which has smaller leaves with less hairy margins, with a smaller point at the apex and with smaller flowers. The name refers to the farm where the type material was collected.

Diosma sabulosa Williams sp. nov. ad basim monocaulis, propria propter planta erecta, folia ovata alterna, ad costa glanduloso-punctata dispersa, marginibus anguste hyalinis, staminodia carens, petula ovariaque glabra.

Frutex c. 1 m, erecta, ad basim monocaulis. *Rami* erecti, graciles, glabrescentes, alterni. *Ramuli* erecti, brevi, graciles, albo-puberuli, foliosi. *Folia* 3–4 mm longa, 2,5–3 mm lata, 5-faria, alterna, patentia, glabra, sessilia, ovata, acuta, mucronulata, marginibus anguste hyalinis serrulatis vel setulosis, intus plana, extus ad costa glanduloso-punctata. *Inflorescentia* terminalia, reductissimo-racemosa; flores pauci, conferti, sessiles. *Bractea* 2,5–2,8 mm longa, 0,8–1,4 mm lata, glabra, sessiles, lanceolata vel anguste ovata, acuta, mucronulata, marginibus ciliolata anguste hyalinis. *Bracteolae* duae, 1,4 mm longae, 0,6 mm latae, deltoideae, acutae, glabrae, carinatae, sub-ciliolatae, 1–2 glanduloso-punctatae. *Sepala* quinque, 1,6 mm longa, 1,2 mm lata, ovata, acuta, glabra, patentia, mucronulata, marginibus ciliolatis hyalinis, costa 1–2 glanduloso-punctata ad apice carinata. *Petala* quinque, 2,5 mm longa, 1,7 mm lata, obovata, sessiles, patentes, alba, ad lateribus sub-ciliolata. *Staminodia* carentia. *Filia* quinque, post anthesin 1,5 mm longa, glabra, aciculares, patentes. *Antherae* quinque, ante anthesin 1 mm longae, 0,7 mm latae, flavescentes, apicibus minute subimmerso-glandulosis. *Pollen* 56 μ longum, 26 μ diam., oblongum. *Discus* 5-sinuatus, parum 5-crenulatus, viridus, succulentus, patens, nectarifer, ovarium magnopere excedens. *Stigma* 0,25 mm diam., globosum, viridum, capitellatum. *Stylus* prima deflexus, deinde erectus, 1 mm longus, glaber, teres. *Ovarium* 5-carpellatum, 0,7 mm diam., *carpella* glabra, apicibus hemisphaericis. *Fructus* 5-carpellatus, 9 mm longus, 8 mm diam., glaber, glanduloso-punctatus, cornibus 2,5 mm longis, patentibus. *Semen* 6–6,5 mm longum, 2,7 mm latum, piceum, nitens.

Type: CAPE—3420 (Bredasdorp): Potberg, in deep sand at base of limestone hills between Buffelsfontein and Cupidoskraal (-BC), 137 m, Bredasdorp Division, 22/1/1975 *Williams 1955* (NBG, holotype; K, M, MO, PRE, S, STE, isotypes).

This plant was first collected by Galpin in 1897 at Melkhoutfontein and then again later by Dr. J. Muir in April 1909. Muir thought it to be conspecific with another hereinafter described for the first time as *Diosma echinulata*. He actually gave his specimen of *D. sabulosa* the collecting number 410 in April and a few months later, in September, when he collected *D. echinulata* he put "=410" on his ticket. Barker (5541) also made a mixed gathering of these two species more or less from the same locality as Muir.

Shrubs about 1 m tall, erect, arising from a single stem at base. *Branches* erect, fairly slender, glabrescent, alternate; bark rough with leaf scars. *Branchlets* erect, short, slender, white-puberulous, leafy. *Leaves* 3–4 mm long, 2,5–3 mm broad, 5-ranked, alternate, spreading, glabrous, sessile, ovate, acute, mucronulate, margins narrowly cartilaginous irregularly serrulate above and setulose below, adaxial surface flat, abaxial surface with gland-dots scattered mainly towards the prominent midrib. *Inflorescence* terminal, a very much reduced raceme; flowers few, crowded, sessile, puberulous below. *Bract* 2,5–2,8 mm long, 0,8–1,4 mm broad, glabrous, sessile, lanceolate or narrowly ovate, acute, mucronulate, margins narrowly cartilagenous, ciliolate. *Bracteoles* two, 1,4 mm long, 0,6 mm broad, narrowly deltoid, acute, glabrous, keeled, sub-ciliolate, with 1 or 2 gland-dots. *Calyx lobes* five, 1,6 mm long, 1,2 mm broad, ovate, acute, glabrous, spreading, mucronulate, margins translucent, ciliolate, with 1 or 2 gland-dots. *Petals* five, 2,5 mm long, 1,7 mm broad, obovate, sessile, spreading, white, sub-ciliolate at the sides. *Staminodes* completely absent. *Filaments* five, becoming 1,5 mm long, glabrous, acicular, spreading. *Anthers* five, before anthesis 1 mm long, 0,7 mm broad, yellowish with a semi-immersed apical gland, becoming reflexed after anthesis. *Pollen* 56 μ long, 26 μ broad, oblong. *Disc* 5-sinuate, slightly 5-crenulate, green, fleshy, stands open, exudes nectar, exceeds the ovary by a long way. *Stigma* 0,25 mm diam., globose, green, capitellate. *Style* glabrous, terete, at first deflexed becoming 1 mm long, erect. *Ovary* 5-carpellate, 0,7 mm diam.; *carpels* glabrous, apices hemispherical. *Fruit* (from *Williams 1873*) 5-carpellate, 9 mm long, 8 mm diam., gland-dotted, glabrous, striate veined when dry; *horns* 2,5 mm long, spreading, apical gland immersed. *Seed* 6–6,5 mm long, 2,7 mm broad, black, shining.

SPECIMENS EXAMINED

CAPE—3420 (Bredasdorp): Potberg, in deep sand at base of limestone hills between Buffelsfontein and Cupidoskraal (-BC), 137 m (450 ft.), Bredasdorp Division, 22/1/1975 *Williams 1955* (NBG, K, M, MO, PRE, S, STE), 21/11/1973 *Williams 1873* (NBG); Limestone hills near Potberg, on rocky plateau, 19/9/1954 *Esterhuysen 23306* (BOL, NBG).
— 3421 (Riversdale): near Askop, south side of main road 10 miles west of Albertinia (-AB), 600 ft., 2/3/1974 *Williams 1881* (NBG); Steenkoolfontein, near Puntjie (-AC), 25/1/1961 *Esterhuysen 28770* (BOL; Trompskop, between Riversdale and coast 25/1/1961 *Esterhuysen 28774a* (BOL); Still Bay hills (-AD), 9/8/1949 *Barker 5541* (*ex parte*) (NBG), 9/8/1949 *Morris 266* (BOL, NBG); near Still Bay, –/4/1909 *Muir 410* (BOL, GRA); Milkwoodfontein, 7/10/1897 *Galpin 3849* (BOL, GRA); National Road near Albertinia (-BA), 7/12/1951

Esterhuysen 19516 (BOL, NBG); between Albertinia and Riversdale, 7/12/1951 *Compton 23175* (BOL, NBG); near Albertinia, 900 ft., 28/10/1971 *Williams 1566* (NBG, STE); Buffelshoek near sea, rocky places (-BC/BD), *Muir 1108* (BOL).

DISTRIBUTION, BIOLOGY AND VARIATION

Diosma sabulosa is found growing in dry sandy soil at altitudes of from nearly sea level at Buffelshoek to about 275 metres above sea level at Albertinia. The westernmost populations occur near the Potberg and Albertinia seems to be the eastern limit of distribution, a distance of about 96 kilometres away. A plant from the type locality about 1 m tall showed 12 annual rings. It would very much appear, from the collections made, that this plant blooms nearly the whole year round but fruits are only to be seen in the latter half of the year from August to December. The reason for this is by no means obvious. It is possible that in the dry part of the year the flowers abort due to drought or to the absence of pollinating agents. The wide open flower with its, at first, deflexed style and the presence of nectar indicate that this species is most probably insect pollinated. The seeds are powerfully ejected when ripe in the hot dry weather by the usual catapult mechanism and, being an erect single stemmed plant that is destroyed by fire, regeneration can only take place from seed.

Variation in this taxon is most obvious in the size of the fruit. Populations at the easternmost limit of distribution have larger fruits with strongly recurved horns.

What is undoubtedly a most closely related species, *Diosma subulata* Wendl., occurs in similar sandy soil behind the dunes and near the sea to the west in the Walker Bay area. Another species, *D. awilana* herein described for the first time, occurs also in sandy soil near Baardscheedersbosch and is also closely related. These three species, which may once have formed part of a cline, are similar in that they possess no staminodes whatever and have glabrous petals. Their rather thin edged leaves show a change from subulate-lanceolate in *D. subulata*, to ovate-lanceolate in *D. awilana*, to ovate in *D. sabulosa*. It is interesting to note that a parallel series of three *Diosma* species occurs on the limestone nearby but these plants all bear small staminodes, and their rather thick edged leaves have apices that change from obtuse in *D. demissa* to a blunt point in *D. guthriei* to a sharp point in *D. echinulata*.

DISCUSSION

This plant is placed in the genus *Diosma* L. because it possesses the following characters one or other of which serve to exclude it from any other genus in the *Diosmeae*: (1) *petals* sessile, clawless; (2) *staminodes* absent; (3) *anther* bears a minute apical gland; (4) *disc* sinuate-crenulate, open, exceeds the ovary by a long way; (5) *stigma* capitellate; (6) *style* short; (7) *filaments* and *style* glabrous; (8) *ovary* 5-carpellate.

Diosma sabulosa is recognised as distinct on account of its being a tall plant arising from a single stem, with leaves ovate, alternate, sessile, gland-dotted towards the midrib with thin translucent margins, without staminodes and with petals and ovary glabrous. It differs from *D. echinulata*, from the neighbouring limestone, which is a small scabrous plant with leaves closely spaced, setose-pubescent with a sharp mucro, thick margins and a short petiole, with petals pubescent and ovary crowned with short setose hairs.

The name refers to the sandy habitat where this plant is found.

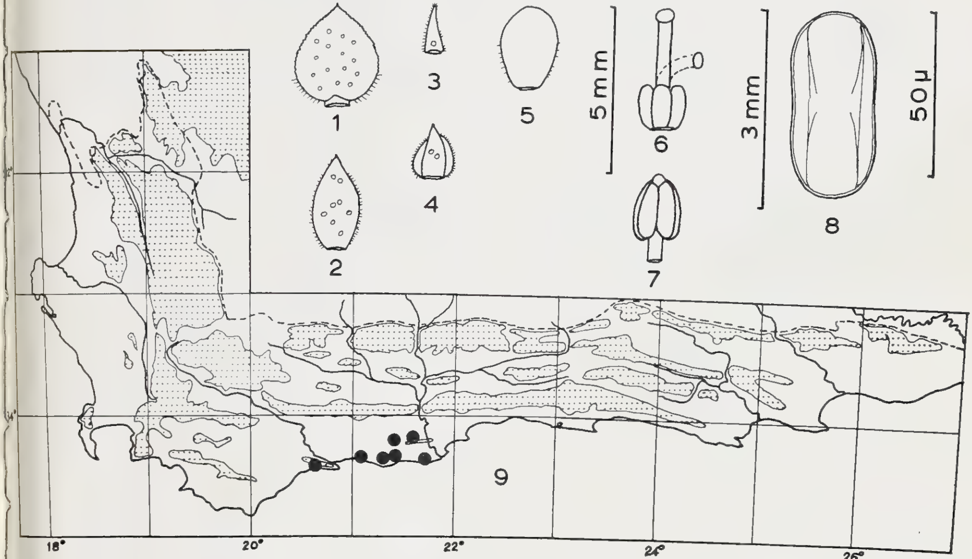

FIG. 7.

Diosma sabulosa: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, petal. 6, gynoecium. 7, anther. 8, pollen. 9, distribution.

Diosma demissa Williams sp. nov. propria propter ramulos dispersos, folia lanceolata obtusa petiolata alterna, cornua brevia.

Frutex ad 25 cm, demissus, effusus, ad basim monocaulis. *Ramuli* brevi, puberuli, numerosi, dispersi. *Folia* ad 5,5 mm longa, 2 mm lata, lanceolata, obtusa, glabra, eciliata, breve petiolata, erecta, conferta, alterna, costis glanduloso-punctatis. *Inflorescentia* terminalia, 1–3 nata, 7 mm diam., alba, sessiles.

Bractea 1,8 mm longa, 1,2 mm lata, sub-ovata, glabra, crassa, marginibus minute serrulatis ad basim ciliolatis. *Bracteolae* duae, 1,5 mm longae, 1,2 mm latae, ovatae, glabrae, sparsim ciliolatae. *Sepala* quinque, 2 mm longa, 1,5 mm lata, ovata, obtusa, glabra, apicibus incrassatis, marginibus hyalinis, ciliolatis. *Petala* quinque, 3 mm longa, 2,2 mm lata, ovata, alba, glabra, sessilia. *Staminodia* quinque, 0,17 mm diam., sphaerica. *Filamenta* quinque, glabra, post anthesin 2 mm longa. *Antherae* quinque, ante anthesin 1,1 mm longae, 0,8 mm latae, aurantiacae, apicibus 0,2 mm diam., glandulosis. *Pollen* 50 μ longum, 25 μ diam., ellipsoideum. *Discus* 5-sinuato-crenulatus, ovarium excedens, patens, nectarifer. *Stigma* 0,3 mm diam., capitellatum, viridum. *Stylus* glaber, 1,5 mm longus. *Ovarium* 5-carpellatum, 0,7 mm diam., glabrum, rubescens. *Fructus* 5-carpellatus, 6,5 mm longus, glaber, cornibus 1,5 mm longis, patentibus. *Semen* 3,8 mm longum, 2,2 mm latum, piceum, nitens.

Type: CAPE—3419 (Caledon): between Stanfords Cove and Die Kelders, near the sea (-CB), 15 m (50 ft.), Caledon Division, 20/7/1974 *Williams 1909* (NBG, holotype; K, M, MO, PRE, S, STE, isotypes).

Diosma demissa was first collected and drawn by Miss M. Walgate (now Mrs. McNae) in December 1940 at Danger Point near the lighthouse. It was subsequently gathered on only about half a dozen occasions but remained unnoticed in various herbaria until the author made the first of several collections in 1972.

Shrubs up to 25 cm tall, pressed down by the wind, spreading about 1 m, arising from a single stem at base. *Branches* variously bent, decumbent, fairly smooth with faint leaf scars. *Branchlets* short, puberulous, pale green, well clothed with leaves, somewhat erect, numerous, scattered, often in clusters. *Leaves* up to 5,5 mm long, 2 mm broad, lanceolate, obtuse, hyaline, margins narrow, rather thick, somewhat serrulate, a single row of gland-dots on the midrib, erect, crowded, 5-ranked, *petiole* 0,4 mm long. *Inflorescence* terminal, 1–3 nate, 7 mm diam., white, sessile. *Bract* 1,8 mm long, 1,2 mm broad, subovate, glabrous, thick, midrib with one gland-dot, margins minutely serrulate, ciliolate below. *Bracteoles* two, 1,5 mm long, 1,2 mm broad, ovate, glabrous, apex thickened, margins translucent, sparsely ciliolate. *Calyx lobes* five, 2 mm long, 1,5 mm broad, ovate, obtuse, glabrous, apex spreading and thickened, hyaline margins broad, ciliolate. *Petals* five, 3 mm long, 2,2 mm broad, ovate, white, glabrous, patent, sessile, connate with the disc. *Staminodes* five, 0,17 mm diam., spherical, vestigial. *Filaments* five, becoming 2 mm long, acicular, glabrous. *Anthers* five, before anthesis 1,1 mm long, 0,8 mm broad, orange coloured, apical gland 0,2 mm diam., spherical. *Pollen* 50 μ long, 25 μ diam., ellipsoid. *Disc* 5-sinuate-crenulate, exceeding the ovary by 1 mm, spreading above, exudes nectar. *Stigma* 0,3 mm diam., capitellate, green. *Style* glabrous, at first deflexed, becoming erect, 1,5 mm long. *Ovary* 5-carpellate, 0,7 mm diam., glabrous, reddened above. *Fruit* 5-carpellate, 6,5 mm long, glabrous, somewhat reddened below, *horns* 2 mm long, spreading, apices depressed. *Seed* 3,8 mm long, 2,2 mm broad, black, shining.

SPECIMENS EXAMINED

CAPE—3419 (Caledon): Die Kelders, car park near Die Plaat, Caledon Division (-CB), 100 ft., 28/3/1972 *Williams 1634* (NBG, STE), 10/6/1973 *Williams 1818* (NBG), 9/11/1962 *Taylor 4279* (STE); between Stanfords Cove and Die Kelders, near the sea, 50 ft., 20/7/1974 *Williams 1909* (NBG, K, M, MO, PRE, S, STE); Romansbaai, Danger Point, Caledon Division, 100 ft., 27/2/1973 *Williams 1771* (NBG); north side of peninsula near Danger Point, 21/1/1946 *Leighton 1554* (BOL); Danger Point, near lighthouse 60 ft., 27/2/1973 *Williams 1770* (NBG), 10/6/1950 *Maguire 12* (NBG), –/6/1950 *Lewis 3368* (SAM), 29/12/1940 *Walgate 85* (BOL), 30/12/1940 *Compton 10219* (NBG); Franskraal, 25/12/1946 *Leighton 2507* (BOL); Hagelkraal (-DA), 25/12/1946 *Compton 18979* (NBG).

DISTRIBUTION, BIOLOGY AND VARIATION

Diosma demissa although quite abundant, is found only in a relatively small area close to the sea in Walker Bay from Die Kelders in the north to Danger Point in the south, a distance of about 11 km, and along the south coast as far as Hagelkraal, a distance of another 12 km. Beyond this point towards the east there seems to be no suitable habitat in which this plant can grow. It grows in small sandy pockets in the tertiary limestone which overlies the Table Mountain Sandstone along the coastal cliffs. This is one of the few plant species able to survive in this exposed habitat with its strong salt laden winds. The bushes spread quite widely but never grow much above 20 cm tall. The stems are tough and variously bent and the twigs are grazed by sheep. Flowering would seem to begin about March and to go on for several months. Ripe fruits can first be found towards the end of July. The plant is destroyed by fire which is fortunately a fairly rare occurrence in this area. Regeneration is from seed ejected, when ripe, in the usual way by a catapult mechanism. The presence of nectar, the, at first, deflexed style and the wide open flower indicate that this species is most probably pollinated by insects.

The leaves when crushed have a strong but sweet resinous smell by no means unpleasant. A section, 6,5 mm diam., from the stem of one plant (*Willams 1818*) showed 8 annual rings and another, 19 mm diam., showed about 25 rings.

There is no apparent variation in this species and up to now no very closely related species has been found nearby. Another species *Diosma guthriei* occupies a similar ecological niche on limestone near the sea. It is found to the east in the Bredasdorp Division.

DISCUSSION

In placing this plant in the genus *Diosma* L. one takes note of the following characters: (1) The *flower* stands wide open with the *petals* clawless, glabrous and sessile. (2) *Staminodes* vestigial. (3) *Anther* with a minute apical gland. (4) *Disc* 5-sinuate-crenulate, exceeds the ovary, spreads open. (5) *Stigma* capitellate. (6) *Style* short. (7) *Style* and *filaments* glabrous. (8) *Ovary* 5-carpellate.

Diosma demissa is recognised as distinct on account of its having alternate branchlets, leaves lanceolate, obtuse, petiolate, 5-ranked, with a single row of gland-dots on the midrib. It differs from *D. guthriei* Glover which has branchlets often dichotomous, leaves much larger, ovate, acute, sessile, opposite or alternate with two rows of gland-dots along the midrib. In *D. demissa* there are two rather characteristic distinct pale green areas one on either side of the midrib. The epithet *demissa* alludes to the modest habit of this plant.

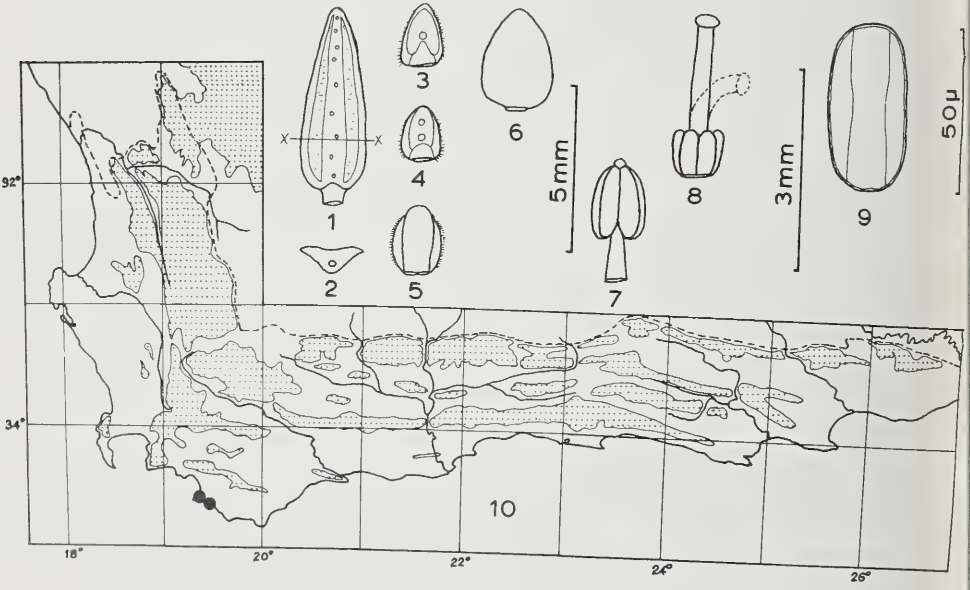

FIG. 8.

Diosma demissa: 1, large leaf. 2, cross section of leaf. 3, bract. 4, bracteole. 5, calyx lobe. 6, petal. 7, anther. 8, gynoecium. 9, pollen. 10, distribution.

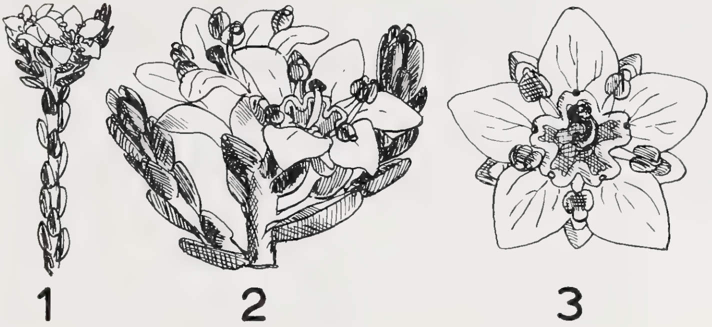

FIG. 9.

Diosma demissa: 1, flowering twig. 2, inflorescence × 3. 3, flower × 4. Drawn by M. Walgate who made the original gathering in December 1940.

Diosma echinulata Williams sp. nov. propria propter folia conferta setosa mucronata crassa petiolata, petala pubescentia, ovarium setulosum.

Frutex c. 40 cm, densus, rigidus. *Rami* brevi, tenices, foliosi. *Cortex* asper. *Ramuli* erecti, brevi, puberuli, sub-fasciculati. *Folia* 5–5,8 mm longa, petiolus 0,5 mm longus inclusus, 2–2,5 mm lata, lanceolato-elliptica, acuta, mucronata, tota sparsim setosa, imbricata, sub-erecta, alterna, 5-seriata, marginibus crassis scabridis, intus plana, extus manifeste nervosa indistincte glanduloso-punctata. *Inflorescentia* terminalia, aggregata; *flos* 5 mm diam., ad instar stellae, sessilis. *Bractea* 5 mm longa, 1–1,5 mm lata, lineara vel linear-oblanceolata, acuta, scabro-mucronata, tota setosa, ciliata, marginibus ad basim anguste hyalinis. *Bracteola* duae, 3–5 mm longa, 0,7–0,9 mm lata, bractea similis. *Sepala* quinque, 3,2–3,7 mm longa, 1,3–1,4 mm lata, anguste deltoidea, acuta, mucronata, tota setosa, ciliata, marginibus ad basim hyalinis. *Petala* quinque, 2,8 mm longa, 1,3 mm lata, oblonga, acuta, apiculata, sessilis, ciliata, intus in medio pauci-villosa, extus puberula. *Staminodia* quinque, c. 0,1 mm diam., vestigialia. *Filamenta* quinque, post anthesin 1,3 mm longa, glabra. *Antherae* quinque, ante anthesin 0,9 mm longae, 0,7 mm latae, luteae, apicibus minute glandulosis. *Pollen* 50 μ longum, 25 μ latum, ellipticum. *Discus* 5-sinuato-crenulatus, patens, viridus, nectarifer. *Stigma* 0,3 mm diam., capitellatum, viridum. *Stylus* 1,4 mm longus, teres, glaber. *Ovarium* 5-carpellatum, 0,7 mm diam., setulosum. *Fructus* 5-carpellatus, 6 mm longus, glaber, indistincte glanduloso-punctatus, cornibus c. 2 mm longus. *Semen* 4 mm longum, piceum nitens.

Type: CAPE—3421 (Riversdale): above Afvalskloof, Vermaaklikheid, Riversdale Division (-AC), 183 m (600 ft.), 21/1/1975 *Williams 1953* (NBG, holotype; K, M, MO, PRE, S, STE, isotypes).

Dr. J. Muir of Riversdale, who was the first person to collect this plant, thought it to be conspecific with *Diosma sabulosa*, another, then unnamed, species which he had collected a few months before and so put his number 410 on this label as well. Although both these plants have been subsequently collected on several occasions they have, up to now, remained undescribed.

Shrubs about 40 cm tall, dense, rigidly bushy and scabrous to the touch, with several branches arising from a stout root at ground level. *Branches* short, tough, with a rough grey-brown bark, remaining clothed with leaves for several years. *Branchlets* erect, short, somewhat clustered, hidden by the leaves, puberulous, 5-angled. *Leaves* 5–5,8 mm long, including the petiole 0,5 mm long, 2–2,5 mm broad, lanceolate-elliptic, acute, mucronate, sparsely setose on all sides, imbricate, sub-erect, alternate, 5-ranked, margins thick and scabrous, adaxial surface flat, abaxial surface with a prominent midrib, gland-dots indistinct and few in number on midrib and margins. *Inflorescence* terminal, with flowers and new shoots clustered together; *flowers* 5 mm diam., star-like, opening in succession. *Bract* 5 mm long, 1–1,5 mm broad, linear or linear-oblanceolate, acute, scabrid-mucronate, setose on all sides, ciliate, somewhat reddened, margins below narrowly translucent. *Bracteoles* two, 3,5 mm long, 0,7–0,9 mm broad, similar to the bract. *Calyx lobes* five, 3,2–3,7 mm long, 1,3–1,4 mm broad, narrowly deltoid, acute, mucronate, reddened above, setose on all sides, ciliate, margins below translucent. *Petals* five, 2,8 mm long, 1,3 mm broad, oblong, acute, apiculate, sessile and somewhat connate with the lobe of the disc, crisped ciliate, rounded at the base, adaxial surface with a few crisped hairs in the middle, abaxial surface puberulous. *Staminodes* five, 0,1 mm diam., vestigial, spherical at the apex of the lobe of the disc. *Filaments* five, becoming 1,3 mm long after anthesis, glabrous, acicular. *Anthers* five, 0,9 mm long, 0,7 mm broad, yellow, with a minute globose apical gland. *Pollen* 50 μ long, 25 μ broad, elliptic. *Disc* 5-sinuate-crenulate, stands open, pale green with a dark green rim, exudes nectar, exceeds the ovary by a long way. *Stigma* 0,3 mm diam., capitellate, green. *Style* at some stage slightly deflexed, becoming erect 1,4 mm long, terete, glabrous. *Ovary* 5-carpellate, 0,7 mm diam., carpels with apices setulose. *Fruit* (from *Williams 1589*) 5-carpellate, 6 mm long, glabrous, indistinctly gland-dotted, with horns about 2 mm long, fairly erect. *Seed* (from *Williams 1589*) 4 mm long, black, shining,

SPECIMENS EXAMINED

CAPE—3420 (Bredasdorp): hills above De Hoop, Bredasdorp Division (-AD), 600 ft., 15/4/1972 *Williams 1648* (NBG); north side of hills on road from De Hoop to Wydgelegen, Bredasdorp Division, 350 ft., 9/4/1974 *Williams 1885* (NBG); Elandspad, Potberg, towards the coast at Stillegat (-BC), 100 ft., 12/4/1972 *Williams 1639* (NBG); Elandspad, Potberg, on road to Noetsie, 300

ft., 2/7/1972 *Williams 1669* (NBG, STE); near Cape Infanta, low stony hills and plateau above coast (-BD), 28/9/1959 *Esterhuysen 28315* (BOL); Voelklip/Graslaagte, Heidelberg duineveld, 125 ft., 27/10/1972 *Williams 1713* (NBG).
— 3421 (Riversdale): above Afvalskloof, Vermaaklikheid, Riversdale Division (-AC), 183 m (600 ft.), 21/1/1975 *Williams 1953* (NBG, K, M, MO, PRE, S, STE); Puntjie, on sand and limestone near the coast, 24/1/1961 *Esterhuysen 28754* (BOL); near Arbiters Kop, Blombos road, limestone hills, 600 ft., 31/10/1971 *Williams 1589* (NBG); hills opposite Still Bay (-AD), 600 ft., –/6/1909 *Muir 410* (*ex parte*) (BOL), -/9/1924 *Muir = 410* (GRA); Still Bay hills, 7/12/1951 *Compton 23182* (BOL, NBG), 9/8/1949 *Barker 5541* (NBG), 7/12/1951 *Esterhuysen 19529* (BOL); 10 miles west of Albertinia, limestone outcrop (-AB), 4/4/1952 *Lewis s.n.* (SAM *67220*), 4/4/1952 *Compton 23328* (NBG), 30/1/1951 *Compton 22581* (NBG, STE).

DISTRIBUTION, VARIATION AND BIOLOGY

The typical *Diosma echinulata* is found growing on limestone hills near the coast from the Duiwenhoks River in the west to just beyond the Kaffirkuils River in the east. Populations further to the west appear to have the leaves more widely spaced, becoming more sessile, the heads less crowded and the fruits and seeds somewhat larger. It is possible that populations will be found nearer to Bredasdorp that will grade into *Diosma guthriei*. The population 10 miles west of Albertinia which is much further inland has the ovary, petals and leaves glabrous. No closely related species appears to have been found further to the east but further to the west, in the Bredasdorp Division, one finds *Diosma guthriei* and still further westwards, near Gansbaai in the Caledon Division, one finds *Diosma demissa* both of which occur on a similar limestone habitat.

The wide open flower with its cup of nectar indicates that this plant is most probably pollinated by insects. Occasional regeneration after fires from the stout rootstock has been noted (*Williams 1669, Williams 1885*) and regeneration from seed also occurs in the usual way. The leaves when crushed have a faint smell of turpentine.

The Riversdale district, at the time when the type collection was made, was in the grip of a very serious drought and great difficulty was experienced in finding flowering material. From collections already made it would appear that, with the exception of periods of drought, flowers may be found throughout the year but ripe fruits are to be found only in the spring. At other seasons flowers must simply abort, indicating some connection with the absence of rain and, or, the possibility of the absence of the required pollinating agents.

The wide open flower has the typical appearance of a *Diosma*. Other characters which also exclude other genera of the *Diosmeae* are: (1) *flowers* terminal; (2) *petals* sessile, clawless, patent; (3) *staminodes* vestigial; (4) *anther* with a minute apical gland; (5) *disc* sinuate-crenulate, stands open, exceeds ovary; (6) *stigma* capitellate; (7) *style* short; (8) *filament* and *style* glabrous; (9) *ovary* 5-carpellate.

Diosma echinulata is recognised as distinct because of its having leaves alternate, closely spaced, setose, mucronate, thick, petiolate, petals pubescent on the outside with a few hairs on the inside at the throat, ovary with the apices of the carpels setulose. It differs from *D. guthriei* Glover which has leaves often opposite, glabrous, sessile, with a blunt point and petals and ovary glabrous. It differs also from *D. demissa* which is an entirely glabrous plant with obtuse leaves. The specific epithet is an allusion to the appearance of the ovary which resembles a minute hedgehog.

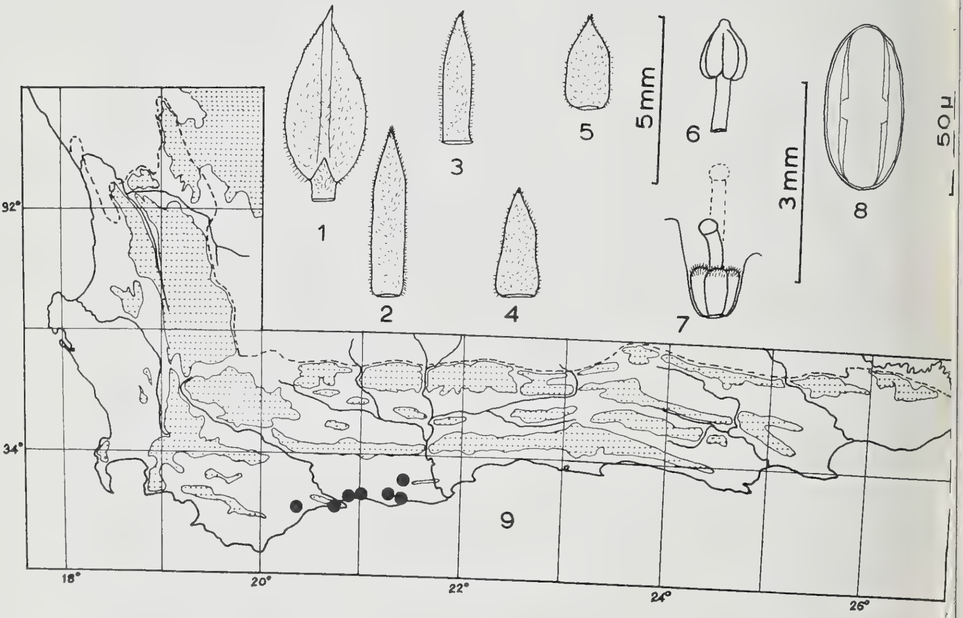

FIG. 10.

Diosma echinulata: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, petal. 6, anther. 7, gynoecium. 8, pollen. 9, distribution.

J! S. Afr. Bot. 41 (4): 269–272 (1975)

NOTE ON THE MECHANISM OF POLLEN RELEASE IN *BRUGUIERA GYMNORRHIZA*

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Abstract

The mechanism of pollen release in the mangrove tree *Bruguiera gymnorrhiza* (L.) Lam. is described. Attention is drawn to the role played by pollinating agents and to the morphological and anatomical adaptations of the petal which facilitate pollen dispersal.

Uittreksel

NOTA AANGAANDE DIE MEGANISME VAN STUIFMEEL VERSPREIDING IN *BRUGUIERA GYMNORRHIZA*

Die meganisme van stuifmeel verspreiding in *Bruguiera gymnorrhiza* (L.) Lam. word bespreek. Aandag word gegee aan die rol van bestuiwers en die morfologiese en anatomiese aanpassings van die blomblare wat verspreiding bevorder.

Observations and Discussion

During a recent visit to the Mangrove swamps at Mtunzini and at Beachwood, Durban, my attention was drawn to the flowers of *Bruguiera gymnorrhiza* which have an interesting mechanism for pollen release. This mechanism has been described in *Bruguiera eriopetala* W. et A., a South West Asian species, but little appears to be known of pollen release in *B. gymnorrhiza*. Lewis (1956) noted an explosive release of pollen from the petals of these flowers and it is the purpose of this paper to outline some aspects of this mechanism.

The flowers of *B. gymnorrhiza* are borne among the terminal leaves of lateral branches (Fig. 1A). The nine to fifteen sepals are green or red-brown in colour and alternate with a similar number of brown conduplicate petals. The stamens lie in two rows, two stamens opposite each petal. In the bud and newly opened flower each petal encloses two stamens (Fig. 1B). In the young bud the filaments are straight but later as the bud matures these elongate and become curved in a characteristic manner (Fig. 1D). This is in contrast to *B. eriopetala* where the filaments are coiled (Gehrmann, 1911). Due to the elongation and folding of the filaments the anthers push against the enfolding petal. The anthers mature just before the flower opens, releasing some of their pollen into the chamber provided by the petals. This phenomenon facilitates pollen release as the pollen grains are free and thus can be thrown more easily from the chamber.

Accepted for publication 9th June, 1975.

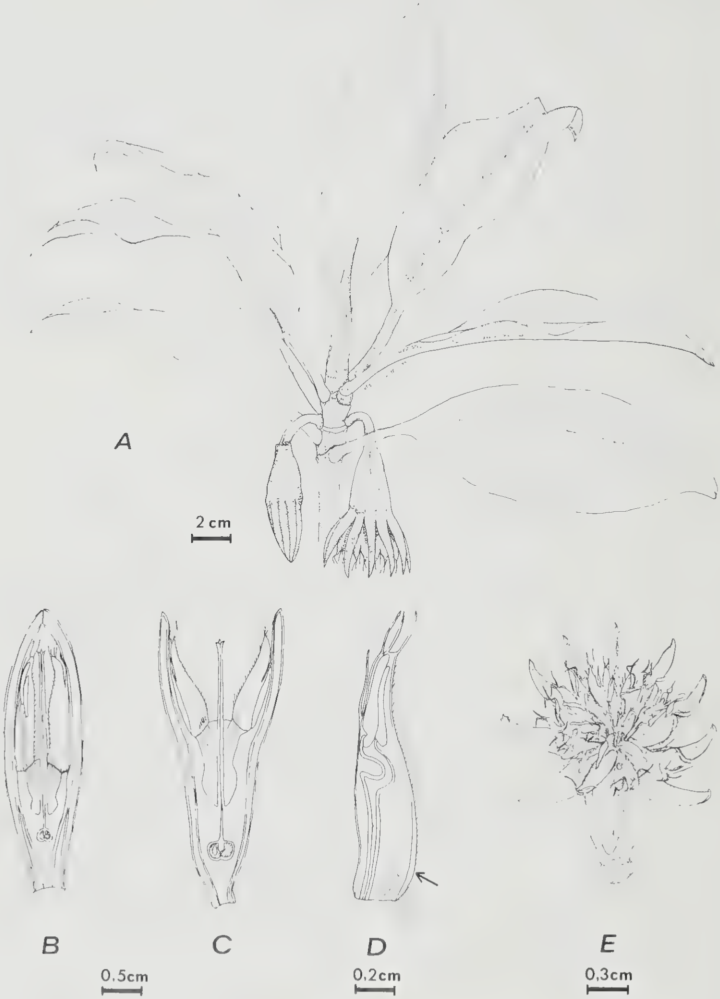

Fig. 1.

The floral structure of *Bruguiera gymnorrhiza.*

A. Pendulous flowers of *Bruguiera gymnorrhiza.*
B. Longitudinal section through a bud showing straight filaments.
C. Longitudinal section through an open flower showing the cupular nectary with overlying hairs.
D. Longitudinal section through the conduplicate petal showing the curved arrangement of the filaments. The arrow indicates the sensitive region of the petal.
E. The flower with all stamens released.

When the bud opens the petals are revealed still enclosing the stamens. A ridge runs along the margin of each petal. This is more prominent at the base where there is a tuft of strong setose hairs. Similar hairs occur along the margins of the petal, on the midrib just behind the anthers, and on the inner surface of the petal in close proximity to the base of the filaments. The petal has a heavily cuticularised epidermal layer through which run a number of vascular strands. The thickening and cuticularisation of the epidermal cells are not uniform. Those cells on the ridges along the margin of the petal are thinner walled and not as heavily cuticularised as the other epidermal cells. The hairs are unicellular lever-like structures, the basal portion forming an integral part of the epidermis (Fig. 2). The hairs at the base of the petal and the heavily ridged region just above the hairs are very sensitive (Fig. 1D). Deflection of the hairs, or a slight pressure in the sensitive region above them with a dissecting needle will cause the petal lobes to spring apart releasing the stamens and a puff of pollen.

In nature pollinating agents are responsible for triggering this mechanism. Bees were observed receiving a shower of pollen over their bodies. Sunbirds were also seen visiting these flowers, pushing their heads well into the flowers in order to gather nectar. The flowers produce copious amounts of nectar. This is contained in a cupular nectary which is partly covered by long sensitive hairs emanating from the base of the petals (Fig. 1C). The nectar contains mainly glucose and some fructose. The nectary wall contains large areas of phloem which probably facilitates the accumulation of nectar.

The manner in which the petals spring open is dependent on a number of factors:

1. the forward and downward movement of the petal as a result of the pressure exerted by the pollinator on the hairs overlying the nectary at the base of the petal,
2. the subsequent pressure of the anthers on the upper margins of the enclosing petal,
3. the rapid unfolding of the filaments,
4. the pressure of hairs behind the anthers on the anthers themselves as the petal opens, and
5. the instability of the petal. The thinner walled epidermal cells along the ribbed margin of the petal become dehydrated after the flower has opened, resulting in a slight outward curvature of the margins. The more heavily cuticularised and thickened epidermal cells become taut. Consequently the margins of the petal spring apart explosively when the hairs at the base of the petal are deflected.

Pollen is not released from all the conduplicate petals of a flower during a single visit of a pollinating agent. However, after three to six days when all the pollen has dispersed (Fig. 1E) the petals and stamens abscise.

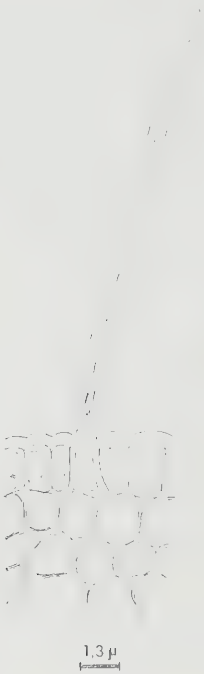

FIG. 2.

A section of the epidermal region along the petal margin.

ACKNOWLEDGEMENTS

I wish to thank Dr. O. M. Hilliard and Dr. J. van Staden for their advice in preparing this paper. The financial assistance of the CSIR is gratefully acknowledged.

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AQUATIC PLANTS OF AUSTRALIA, by Helen I. Aston, with pp. xv+368, 138 black and white line drawings and 81 distribution maps: Melbourne University Press, 1973. £15.80.

When confronted with a pail of foetid water, wherein are floating a few decaying fragments of aquatic flora, hopefully submitted for identification, most botanists are overcome by a deep sense of helplessness. Moreover, if one happens to live in a part of the world not well served by an up to date Flora, the helplessness soon turns to frustration or even suicidal despair as the absence of any taxonomic literature becomes more and more apparent. The collection and study of aquatic vascular plants has never been a popular field of taxonomic endeavour, with the inevitable result that reliable publications on aquatics are few and far between. Australians (and others for that matter) should therefore be more than grateful to Helen Aston for her attractive treatise, *Aquatic Plants of Australia*, as it fills a considerable gap in the literature.

After a short introductory account of the aquatic environment in Australia, the bulk of the book is devoted to a systematic enumeration of some 222 species which are regarded as aquatics—a large number for so dry a continent as Australia. These are chiefly Angiosperms, but the Characeae, Ricciaceae and Pteridophyta are included for convenience. While the book is designed to serve the needs of Australia as a whole, it is heavily weighted in favour of the state of Victoria, not unnaturally perhaps, as it is one of the moister regions of the Commonwealth and also the region which is best known to the author. Nevertheless, despite this apparent limitation, it will certainly be of general interest, especially to other southern hemisphere countries since aquatics, particularly those with weedy tendencies, have a nasty habit of turning up unexpectedly as unwelcome immigrants.

Several species such as *Nymphoides indica*, *Triglochin striata*, *Cotula coronopifolia* and *Nymphaea capensis* will be familiar to South African readers. *Aponogeton distachyos*, the Cape Water Hyacinth, now naturalized in Victoria, is included too, although the specific epithet is spelled *distachyon* (as in the *Flora Capensis*) rather than *distachyos* as in the *Flora of Southern Africa* vol. 1.

For most taxa, full descriptions are provided with notes on synonymy and distribution data as well as a distribution map for the state of Victoria. There are keys to the genera and species, although there is no overall key to the families. In mitigation, however, it must be pointed out that this deficiency is more than compensated for by the abundance of beautifully clear line drawings;—undoubtedly one of the outstanding features of this publication. It is intended that these detailed illustrations, with their strong emphasis on diagnostic characters, should serve as a visual key. Many of the drawings are by the author herself. An illustrated glossary, maps and tables of units on the end papers, a chart showing the distribution of the species discussed, state by state, and an extensive bibliography round off this book, making it a very useful self-contained unit.

Professional botanists in Australia will surely be grateful for this work which should serve their needs for many years to come. But, I very much doubt whether it will appeal, as the author hopes, to the "amateur enthusiast, including the layman who knows only the elementary parts of a plant", especially when priced at an exorbitant £15.80. At this price, even institutional libraries, particularly those outside Australia and more particularly those short of shekels, will have to think twice before adding this worthy publication to their shelves.

J. P. ROURKE

FRAGILE ECOSYSTEMS. Evaluation of Research and Applications in the Neotropics, edited by E. G. Farnworth and F. B. Golley. A report on the Institute of Ecology (TIE), June, 1973, with pp. xxvii & 258, 11 figs. Berlin–Heidelberg–New York: Springer-Verlag, 1974. Soft cover DM 19, 20; US $7.80.

The objective of the Institute of Ecology was to review the state of knowledge in tropical ecology and recommend profitable areas for research. Their reports are summarised in the book which is divided into six sections dealing with populations, communities, ecological succession, impact of technology on environment, regional impacts of man, and mechanisms

to support research. The Institute's deliberations were designed to provide guidance to the National Science Foundation of the United States on their allocation of research support to the tropical regions of America. It is, therefore, to be expected that the book deals with environmental topics in as broad a perspective as possible, in order to appeal to a variety of scientists and decision makers in many countries and of varied political persuasions. But the American bias means that the volume is of limited interest to South Africans, and perhaps restricted to the more serious students of environmental studies who would find it a useful reference.

E. MOLL

COMPARATIVE MORPHOLOGY OF VASCULAR PLANTS, by Adriance S. Foster and Ernest M. Gifford Jr. Second edition with pp. ix + 751, 440 figs., 4 tables. San Francisco: W. H. Freeman and Company. Price $8-00.

Vir diegene wat intieme kennis het van Foster en Gifford se *Comparative morphology of vascular plants* wat in 1959 verksyn het, sal dit 'n groot vreugde wees om te verneem dat 'n tweede uitgawe van die boek verskyn het.

Hoewel hierdie tweede uitgawe ongeveer 200 bladsye en 2 hoofstukke meer beslaan as die eerste uitgawe en die bladsye 'n groter formaat het, dek dit dieselfde veld. Nuwe resultate en opvattings is geïnkorporeer sodat die boek 'n byderwetse beeld van die vergelykende plantmorfologie gee en met vertroue vir studente voorgeskryf kan word.

Hierdie boek het waarskynlik geen gelyke in die Engelstalige plantkundige literatuur nie. In die eerste ses hoofstukke word 'n deeglike vergelykende uiteensetting van die morfologie van die vaatplante gegee. In hierdie uiteensetting word aan die vergelykende embriologie—generasiewisseling, sporogenese, gametogenese en embriogenese—wat van so veel belang is om die onderlinge verwantskap van die Embryophyta en Tracheophyta te begryp, prominensie verleen.

Met die gegewens van die eerste ses hoofstukke as basis, word die verskillende groot groepe van die vaatplante in die orige vyftien hoofstukke behandel. Die morfologie van die sporofiet sowel as dié van die gematofiet, die voortplanting en die ontogenie van elke groep word bespreek met die klem op bepaalde tipes. Die fossiele groepe, veral dié wat morfologies en filogeneties van besondere belang is, word in die regte perspektief gestel. Meer as in die eerste uitgawe word aandag gewy aan die faktore wat groei en ontwikkeling beïnvloed.

Die boek met sy goeie papier, netjiese illustrasies en mooi drukwerk skep 'n baie goeie indruk. Die teks is deeglik gedokumenteer en na elke hoofstuk is 'n lang lys van literatuurverwysings. 'n Omvattende indeks stel die gebruiker in staat om die onderwerpe in die teks te vind.

Die leerstof is duidelik uiteengesit en die boek kan met vrug vir voorgraadse studente voorgeskryf word. In die meeste plantkunde-departemente sal al die onderwerpe sekerlik nie in die voorgraadse kursusse behandel word nie. In sulke gevalle sou die boek ook deur nagraadse studente gebruik kan word.

Omdat die boek hom toelê op die basiese leerstof van die vergelykende morfologie en voorbeelde gebruik wat internasionaal bekend is, kan dit in enige deel van die wêreld gebruik word.

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